SATS Technical & Partnering Workshop Proceedings

Contents

NASA Aerospace Technology Enterprise
Small Aircraft Transportation System

SATS Overview

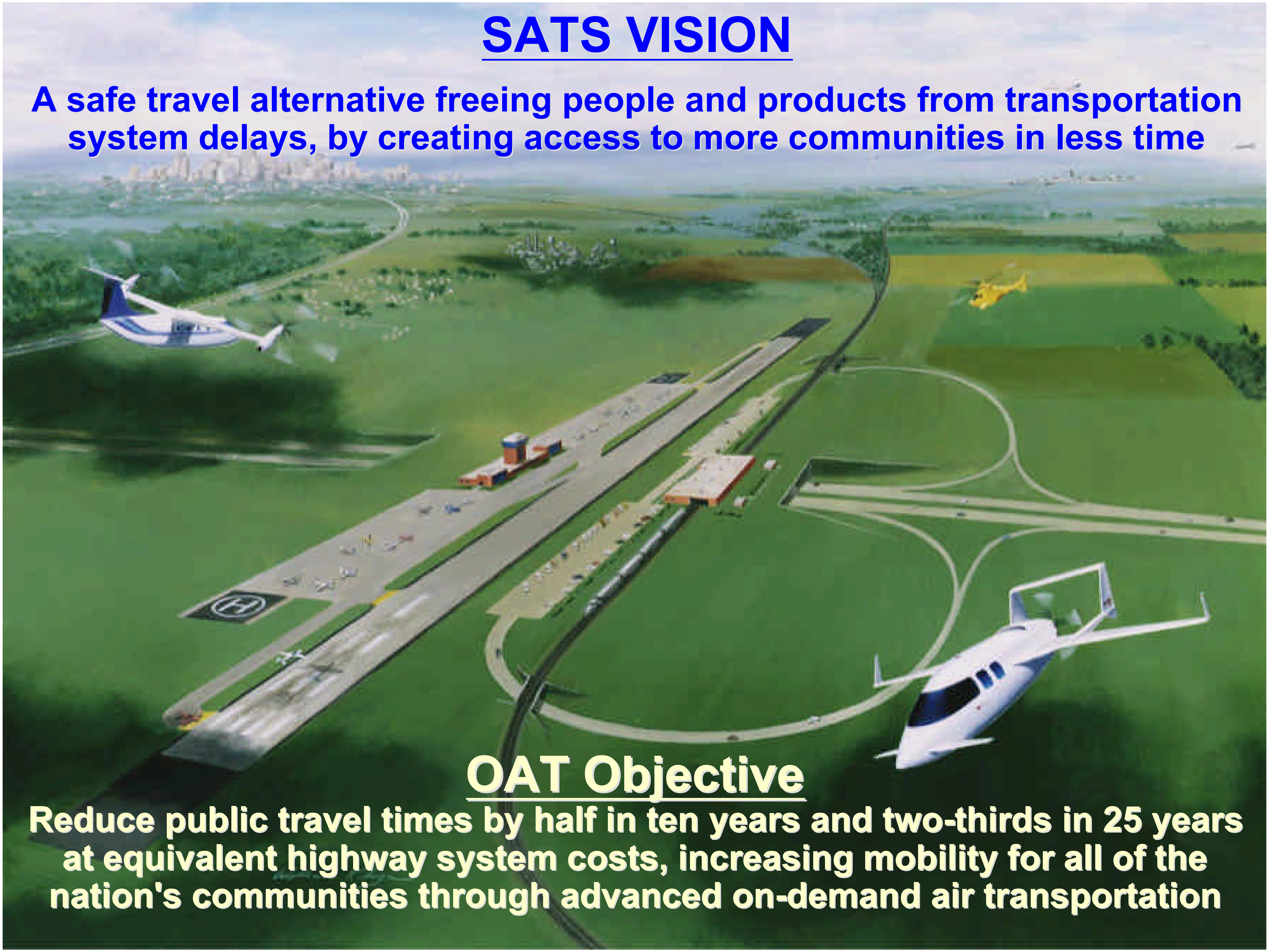
SATS Planning Workshop
Omni - Newport News, VA
January 23, 2001

Figure 1

Outline

- **SATS Program Overview**
- **SATS Technical Project Status**

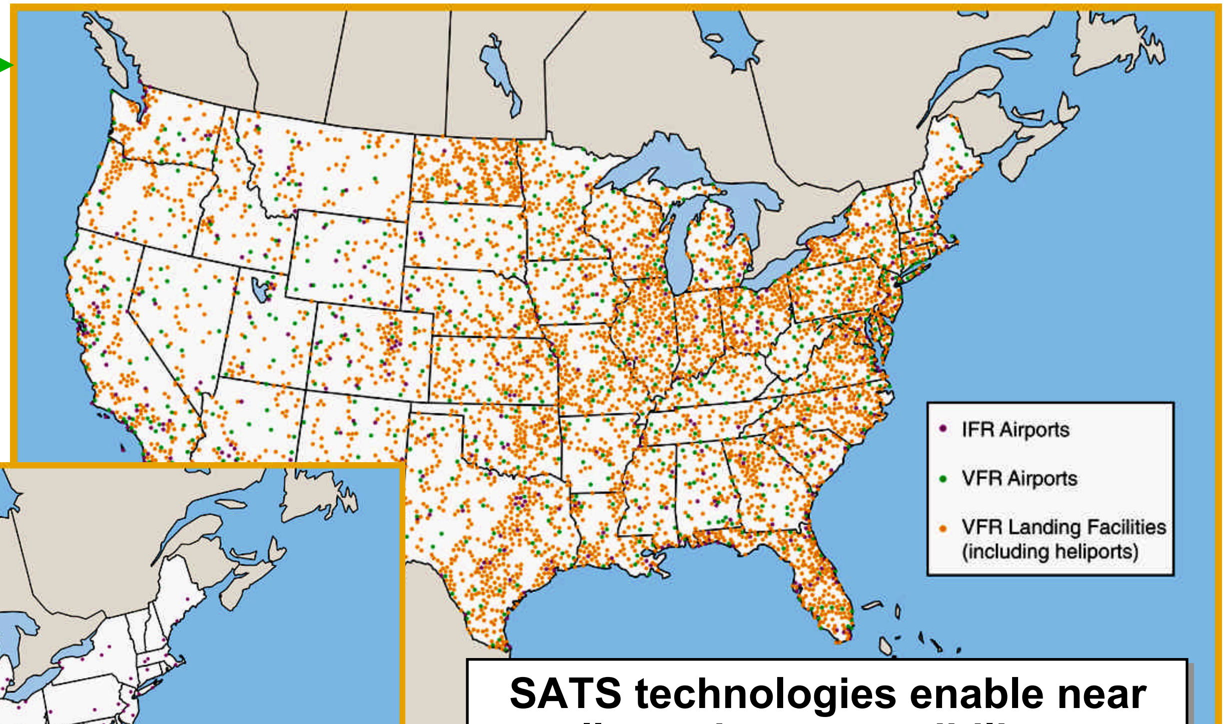
Figure 2


SATS VISION
A safe travel alternative freeing people and products from transportation system delays, by creating access to more communities in less time
OAT Objective
Reduce public travel times by half in ten years and two-thirds in 25 years at equivalent highway system costs, increasing mobility for all of the nation's communities through advanced on-demand air transportation

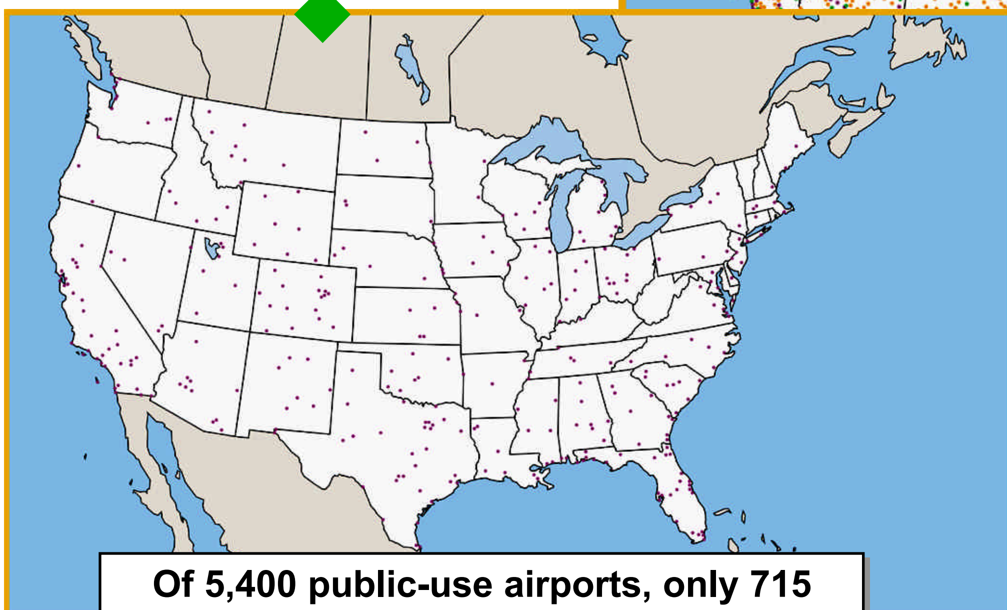
We Have an Abundance of Airspace

But Not By Using Today's IFR System!

Expanded Accessibility to several times more destinations



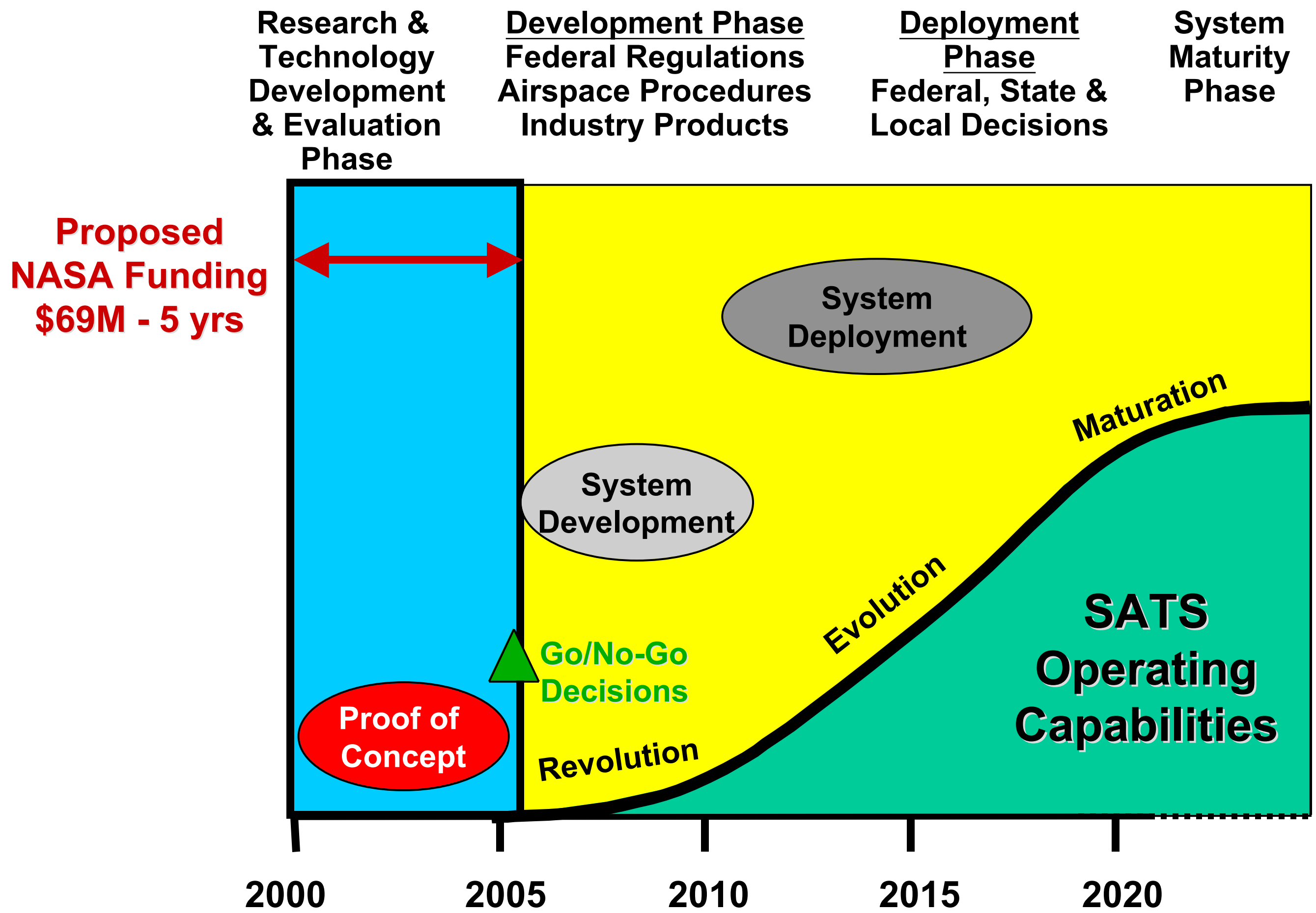
SATS technologies enable near all-weather accessibility to virtually any of the nation's 18,000 landing facilities.



Of 5,400 public-use airports, only 715 (13%) have precision instrument approaches (ILS)

Figure 4

First Step Is To "Prove SATS Works"



Proposed NASA Technology Demonstration:

- Deliver experimental-based technical basis for national decisions
- Deliver analytical-based proof that SATS is a viable transportation alternative

Figure 5

NASA SATSLab 5 Year Program

5 Year Goal

Demonstrate key airborne technologies for precise guided accessibility in small aircraft in near all weather conditions to virtually any small airport** in nonradar, nontowered airspace*

Objectives *(NAS Benefits)*

- Higher-Volume Operations in Non-Radar Airspace at Non-Towered Facilities *(Expansion of Capacity)*
- Lower Landing Minimums at Minimally-Equipped Landing Facilities *(Cost of Expansion)*
- Increase Single Crew Safety & Mission Reliability to Two-Crew Levels *(Greater Throughput)*
- Enroute Procedures & Systems for Integrated Fleet Operations *(Reduced Ground Holds)*

Technical Challenges & Issues

- Technology/System Integration
- Economic Viability
- Level of: Automation vs. Training
- Validation of Complex Software
- Systems Integrity

Approach

- Virtual VMC
- High Density Operations
- Systems Analysis & Assessment
- Integrated Systems Demonstrations

Enabling Technologies

- Enhanced Vision
- Highway in The Sky (HITS) Phase III
- Software-Based Flight Controls
- Airborne Internet
- Emergency AutoLand
- Self Organizing Sequencing & Separation Algorithms

Figure 6

NASA RESEARCH INITIATIVE

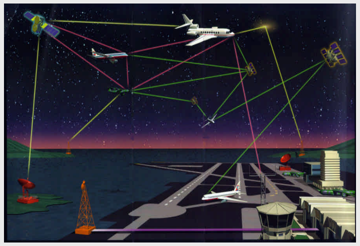
“Prove SATS Works”

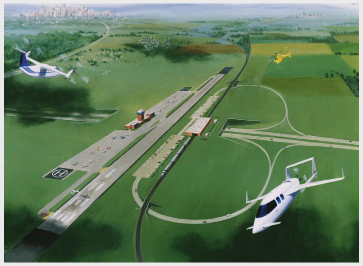
‘Virtual VMC’ (Visual Meteorological Conditions)

Prove that SATS cockpit technologies enable low visibility operations in near all-weather conditions with the same level of safety and efficiency as today’s two-pilot large commercial aircraft operations

High-Density Operations

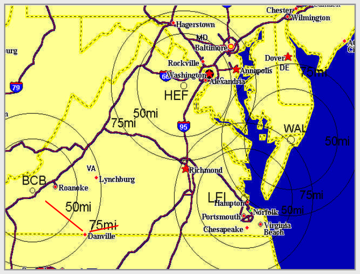
Prove that SATS airspace technologies enable safe operations in non-towered, non-radar airspace while enabling significant improvements in air traffic density at small airports and overall system capacity





Systems Analyses & Assessment

Prove that SATS is an viable transportation investment alternative for the nation that promotes economic development and provides faster doorstep-to-destination travel time with greater accessibility to small communities



Technology Integration & Flight Demonstrations

Showcase key technologies in an integrated ‘proof-of-concept’ flight demonstration at multiple small airports that validates the SATS operational concept and *“PROVES SATS WORKS”*

Outline

- **SATS Program Overview**
- **SATS Technical Project Status**

Figure 8

High Density Operations

Peter A. Padilla, Ph.D.

SATS Capabilities/Goals

_ **Higher Volume Operations at Non-Towered/Non-Radar Airports**

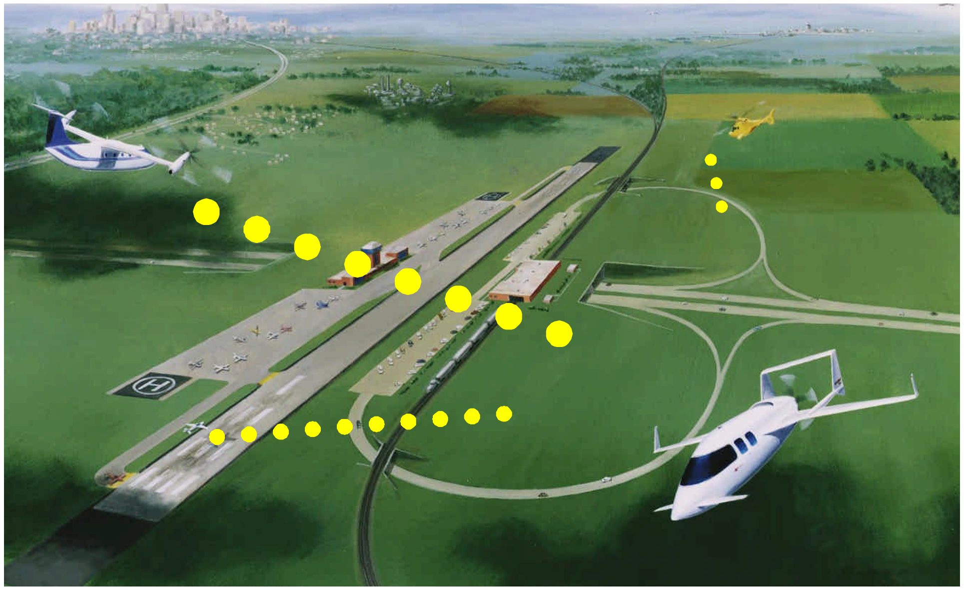
  _ **Provide concepts and algorithms that enable a safe, self-organizing airspace that provides collaborative decision making between vehicles for:**

    _ **Sequencing**

    _ **Separation**

    _ **Conflict detection & resolution**

    _ **Known hazardous weather avoidance**



  _ **Approach paths algorithms that dynamically account for traffic, terrain, NOTAMs, and airspace restrictions**

Figure 2

HDO Key R&D Topics

- **Separation assurance algorithms (strategic)**
- **Conflict detection & resolution (tactical)**
- **Collaborative sequencing (decision-support agents & tools)**
  - **Airborne**
  - **Minimal/no ground support**
  - **Likely non-normal conditions**
- **Dynamic approach path to destination runway**
- **Flight operations and airspace design**
- **ATM and FIS requirements**
- **Formal Methods application to algorithm design**

Challenges

- On-board data fusion of
  - ATM
  - FIS
  - Surveillance
  - Navigation
  - Aircraft systems status
- Dynamic approach path generation
- Complexity of algorithms and operational procedures
  - Accounting for non-normal conditions
- Hazardous weather prediction accuracy
- Systems integrity requirements

Candidate Experiments

Approach

- _ **Monte-carlo simulations**
- _ **Pilot-in-the-loop ground simulations**
- _ **Flight experiments**

Experiments

- _ **Conflict detection & resolution for multiple (2+) a/c**
- _ **Approach path generation**
- _ **Separation**
- _ **Sequencing**
- _ **Non-normal conditions/emergency procedures**

Figure 5

VIRTUAL VISUAL METEOROLOGICAL CONDITIONS (VVMC)

Ken Goodrich
Dynamics and Controls Branch, NASA LaRC
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VVMC CAPABILITIES AND GOALS

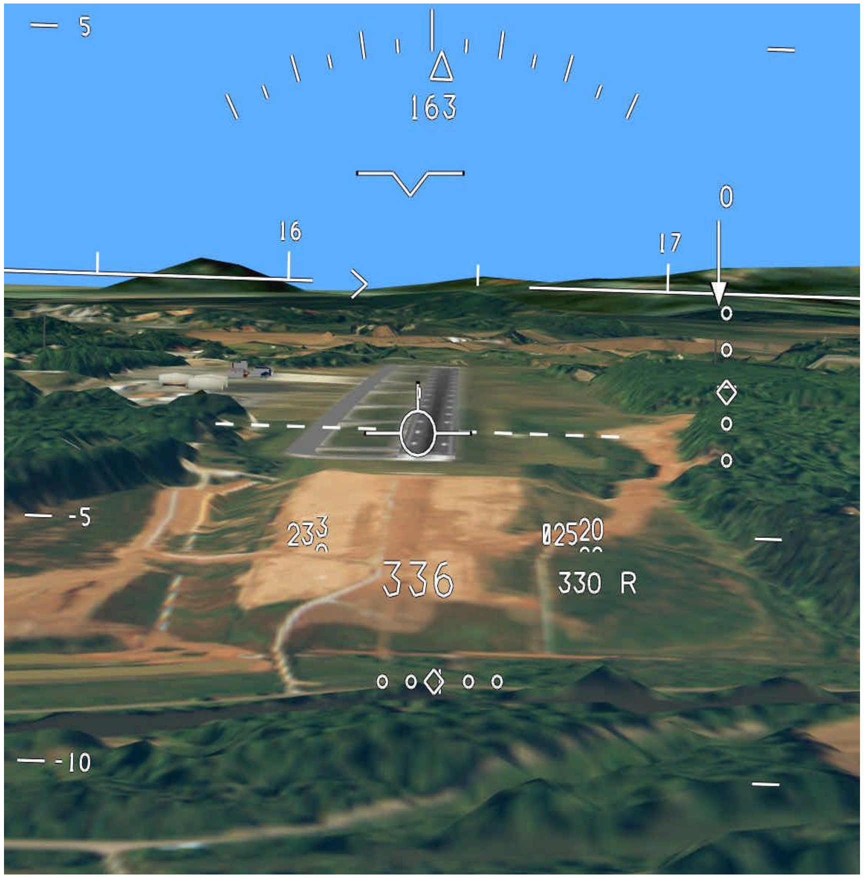
- Low-visibility approaches at minimally equipped landing facilities
  - Cat 1 minimums or lower (stretch goal – _ mile visibility)
  - Minimal airport infrastructure
    - Lights, ground based nav. aids, markings
  - VFR air and ground space protection requirements
- Improved single-pilot performance in complex, evolving NAS (ATP like performance from private pilot)
  - Safety
  - Task precision
  - Workload
  - Training
- Technologies must be cost effective!

VVMC ASSUMPTIONS

- Future airspace capacity needs and community compatibility requires precise tracking of dynamic, steep, curving, 4D flight paths and approaches
  - far more demanding than 3 mile, stabilized approaches
- SATS vehicles will be flown by relatively low-time pilots (>100 hours)
  - Air-taxi pilots for 10,000's of point to point ops.
  - Non-compensated pilots (i.e. private pilots)

VVMC R&D TOPICS

- Precise vehicle control along steep (>>3 deg.), curving, 4D approach path
- Loss of control prevention
- Rapid transition between instrument and visual references—or eliminate transitions
- Obstacle detection and avoidance
- Integrated display of traffic information
- Automated decision aids to enhance tactical and strategic decision quality
- Low-cost, fail-operational and fail-safe systems and automation



COCKPIT INTEGRATION IS CRITICAL TO SUCCESS

VVMC CHALLENGES

- Technology in place of pilot skill and training
  - Simplified user interface (human centered automation)
  - Automation / system integrity
  - Certification (equipment and pilots)
  - Liability
- Data demonstrating that total system performance achieves improved levels of safety during near-all weather operations
  - Navigation performance + flight technical error compatible with revised TERPS criteria for SATS operations
  - VFR RPZ provides desired protection to people and property on the ground
  - Overall safety >> than current small aircraft ops.

VVMC 2003/4 Experiments Examples

- Pilot-in-the-loop ground simulations
- Flight experiments
- Monte-Carlo, batch simulations (high run volumes)

- Levels of control/display automation
  - Envelope protection
  - FBW, Velocity vector control/display
  - Fully automatic (including autoland)
- Low-visibility displays
  - Head-up vs Head down
  - Literal vs. abstract
- Procedure and approach path complexity
- Traffic display formats for pilot monitoring and performance of separation and sequencing
- Decision aids for routine, non-normal conditions and emergency procedures

VVMC CONCLUDING REMARKS

- ✈Many technology components exist or emerging in other applications
  - Commercial aviation
  - Military—manned and uninhabited
  - Non aerospace
- ✈Integration of technologies and development of compatible procedures key to project success
- ✈ Assess transportation value of increasing levels of technology

Virginia SATSLab Research and Operational Evaluation

Program Approach

Dr. George L. Donohue

Department of Systems Engineering and Operations Research

January 23, 2001

Outline

- **Overview**
- **High Density, Non-Tower Operations**
- **Simplified Adverse Weather Landings**
- **En-Route Airspace Compatibility**
- **Single Pilot IMC Operations**

Proposed Research Alliance: Academia

- **George Mason University**
  - Systems Analysis, Flight Test
  - CHI Efficacy and Pilot Cognitive Workload
- **MIT Lincoln Labs (FFRDC Cooperative Alliance)**
  - Evaluate Advanced surveillance and data-link systems
- **Ohio University**
  - DGPS analysis and evaluation
  - Advanced Avionics support and evaluation
- **Old Dominion University**
- **Virginia Tech**
  - Develop and Evaluate New TERPS Methodology (special emphasis on mountainous terrain)
  - Model inclusion of Human Factors

Virginia SATSLab Industrial Participation

- **Modeling**
  - **Logistics Management Institute**
- **Surveillance Systems**
  - **SENSIS, Inc.**
  - **MIT/LL**
- **Avionics**
  - **ARNAV, AVIDYNE, AURORA Flight Sciences Corp.**
- **Flight Training Schools**
  - **(3) HEF flight schools**
- **Data Link**
  - **ARNAV, ARINC**
- **Systems Engineering, Safety Analysis, Flight Testing**
  - **Trios, Associates**
  - **Aviation Systems Engineering, Inc.**
  - **A.D.Little**
- **Aircraft Manufacturer**
  - **`Cirrus**

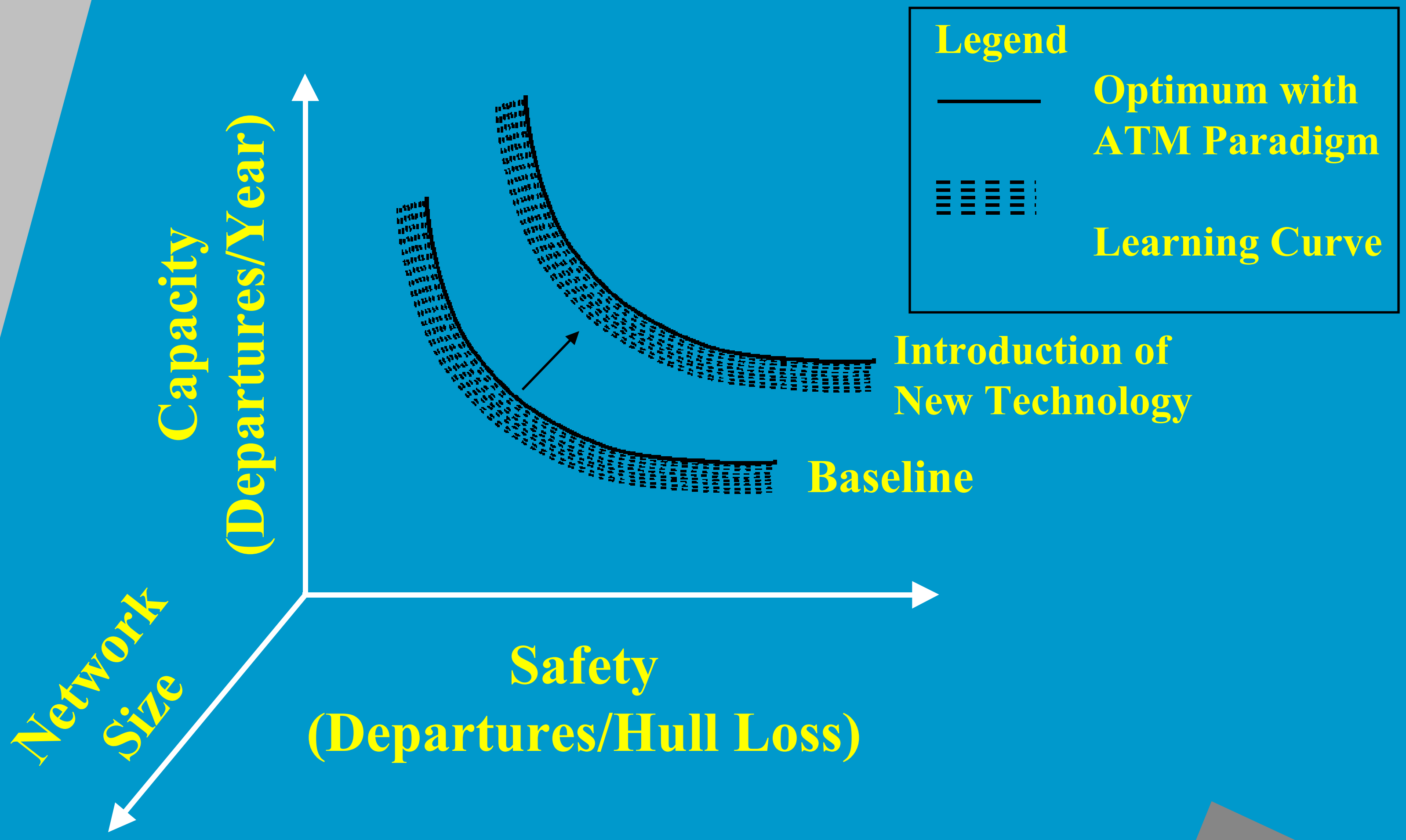
SATS (Small Aircraft Transportation System): Major Research Issues

- **Four Primary Technical Barriers to SATS Vision**
  - **1) High Volume Operations at Airports w/o Control Towers**
  - **2) Lower Adverse Weather Landing Minimums**
  - **3) SATS and Enroute airspace Compatibility**
  - **4) Single Pilot Ability (IFR) to function Competently in Complex Unstructured Airspace**

Central Research Challenge

- Design and Evaluate Decision Support Systems to Safely Sequence and Separate Single Pilot Operated Aircraft in High-Density, Mixed Equipage, Class E (and Class F ?) Airspace under IMC Conditions

Capacity-Safety Substitution Curves



Virginia Research and OPEVAL SATS-Lab Focus

- **SATSLab Proposes to Combine Data Analysis, Modeling and Field Testing leading to FAA Certification/Operational Directives:**
  - **High Density Air Space w/o Towers**
    - **Functional Hazard Safety Analysis: equipment and operational procedures**
    - **Modeling and Simulation**
    - **Community environmental acceptance**
  - **SATS and En Route Airspace Compatibility**
    - **Modeling and Airspace design**
  - **Single Pilot IFR Workload and Human Factors**
    - **Cognitive Workload Analysis**
    - **Training Procedures and effectiveness**
  - **IFR Landings with simplified TERPS**
    - **Modeling and Experiments**

Proposed Issues to be Addressed by Virginia SATSLab Research

Specific Research Issues to be Addressed:

- **Airport must have a layered air and ground based system that safely allows mixed equipped aircraft to self-separate. What layers? How many layers?**
- **How is the airspace to be restructured to accommodate Heterogeneous Aircraft mixture?**
- **Single Pilot workload in less structured Airspace is much more difficult than Commercial CRM HF. How do we use Technology and Operational Procedures to Compensate?**
- **What is a minimally equipped aircraft? At what cost?**
- **What is the Proper IFR Training Syllabus?**
- **How well do new pilots operate in this environment?**
- **Will the Community Economic Benefits outweigh the Environmental Impact**

Virginia SATSLab Level 4 WBS (DRAFT)

Virginia SATSLab Alliance
Level 4 Draft Work Breakdown Structure

- FAA LABS
- Virginia SATSLab
- NASA LABS

Virginia SATSLab:

- 1.0 Program Management
  - 1.1 GMU
    - 1.1.1 Monthly Financial
    - 1.1.2 Quarterly Technical
    - 1.1.3 Annual Report
    - 1.1.4 Qrty. AOC Mtg
    - 1.1.5 FAA Liason
    - 1.1.6 NASA Liason
    - 1.1.7 NATCA Liason
    - 1.1.8 HEF Liason
  - 1.2 VT
  - 1.3 OU
  - 1.4 MIT/LL
  - 1.5 A.D.Little
  - 1.6 SENSIS
  - 1.7 Trios Assoc
  - etc
- 2.0 High Density Towerless Airport
  - 2.1 TAAM sim GMU/VT
    - 2.2.1 TAAM HF VT
  - 2.2Community Impact GMU
  - 2.3 Surveillence SystemsGMU
    - 2.3.1 MultiLat SENSIS
    - 2.3.2 TCAS MIT/LL
      - 2.3.2.1 TCAS
      - 2.3.2.2 Mode--S
    - 2.3.3 Fusion LockMart
  - 2.4 Data Link Trios
    - 2.4.1 Mode-S MIT
    - 2.4.2 VHF Trios/ARNAV
  - 2.5 A/C Avionics Dulles Av.
  - 2.6 Ops Test Plan GMU/ADL
  - 2.7 A/P Infrastructure VDOA
  - 2.8 FAA Proc. Cert. ASE
- 3.0 All Weather Minimums
  - 3.1 DGPS OU
  - 3.2 V TERPS VT
    - 3.2.1 FAA Cert ASE
  - 3.3 Synthetic Vis. OU
    - 3.3.1 FAA Cert ASE
- 4.0 En Route Interface
  - 4.1 TAAM sim GMU/VT
  - 4.2 LMINET sim GMU/LMI
  - 4.3 Potomac Met. Cood. GMU
  - 4.4 Airspace Anal/Design GMU
- 5.0 Single Pilot IFR
  - 5.1 Cognitive WL GMU
  - 5.2 Displays GMU/VT
    - 5.2.1 Ergonomics VT
    - 5.2.2 Comparisons GMU
  - 5.3 Auto Land Aurora FSC
    - 5.3.1 Self Sep. GMU
  - 5.4 FAA Cert ASE

Proposed Virginia SATSLab Schedule

- CY 2001 (April-October)
  - Expand CONOPS/Architecture/Cert Plan Details
  - Refine Detailed Research Plan
  - Conduct Initial Safety, Airspace and Environmental Analysis
  - Develop Human Factors Experimental Design
  - Acquire and Install Flight Simulator
- CY 2002
  - Acquire and install Aircraft Avionics
  - Begin conduct of Human Factors Evaluations (Sim+Flight Test)
  - Evaluate (Models+Flight Test) New Operational Procedures
  - Continue Safety and Airspace Analysis
- CY 2003
  - Continue Human Factors Evaluations (Sim+Flight Test)
  - Design and Conduct First DEMVAL (Sim+Flight Test)

Proposed NASA-Research Alliance Coordinated Schedule

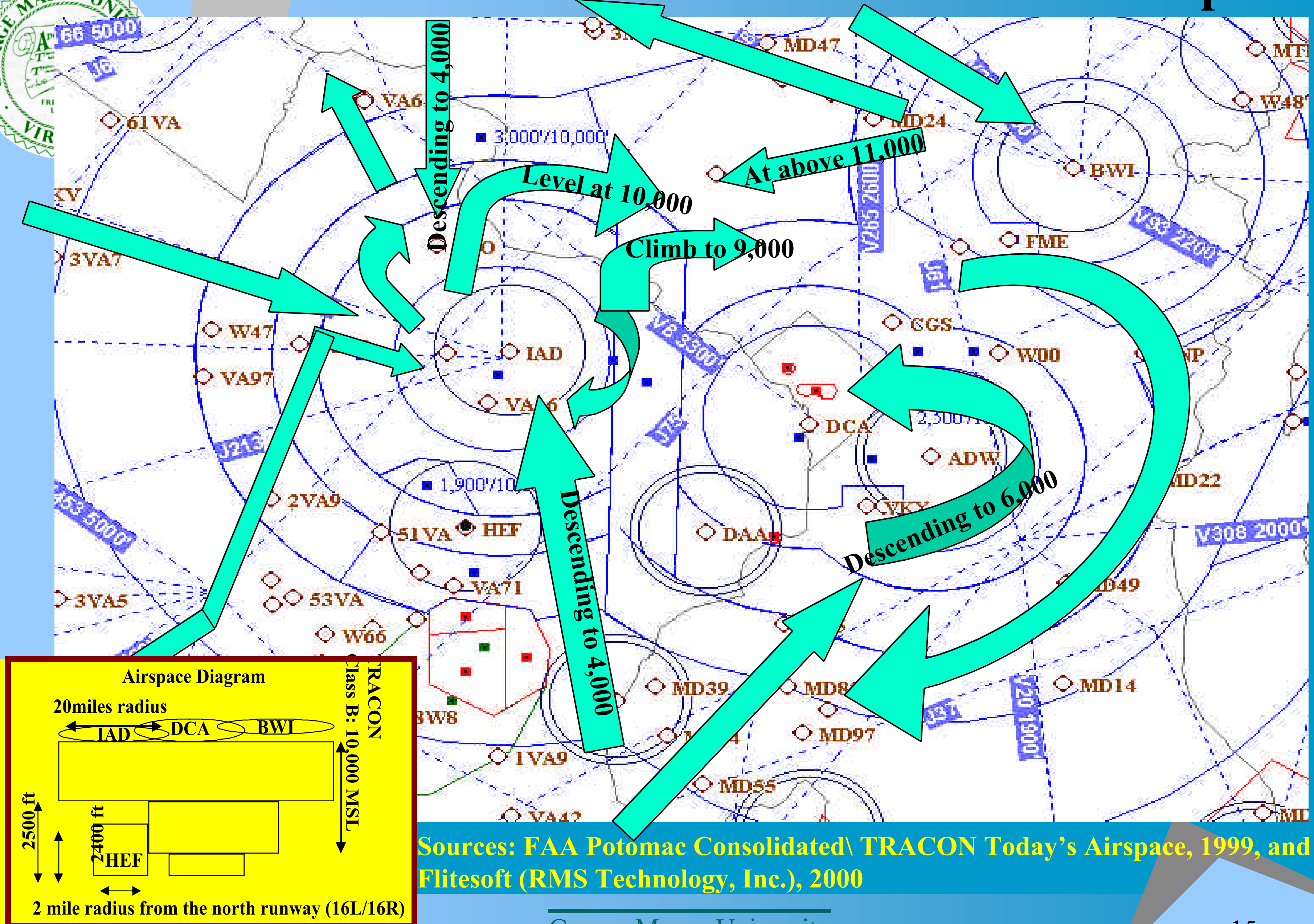
- CY 2001 (April-October)
  - Award 2 or more Research Consortia/Alliance Competitive, Multi-year Collaborative Research Alliance (CRA) Grants
  - Use Grants and NASA Labs to Refine Detailed Research Plan
  - Conduct Competition and Award Systems Engineering & Management Team (SEMT) contract
- CY 2002
  - SEMT begin Consortia/Alliance/NASA Lab/FAA Lab Research Plan Coordination
  - NASA/SEMT Develop Detailed 5 Year Milestones and Metrics
  - Conduct Detailed Program Reviews
  - Begin 2003 OPEVAL Test Plan
- CY 2003
  - Continue Program Reviews and Research Harmonization
  - Approve and Conduct First OPEVAL (Flight Test)

Back-Up Slides

Premise of This Presentation

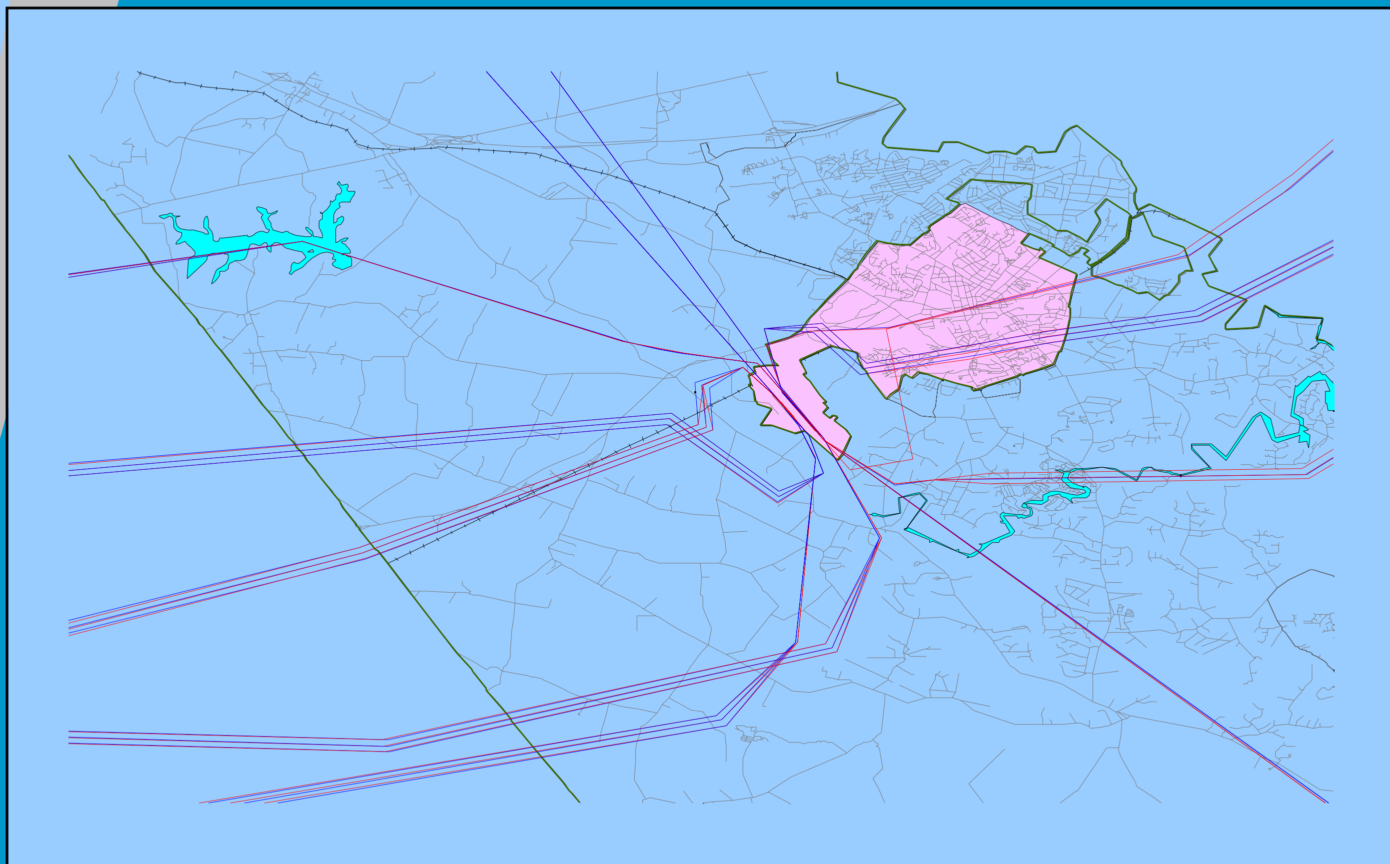
- It is desirable to have a Research Alliance led by Virginia Universities involved in the NASA SATS Research Program
- The Virginia Department of Aviation (VDOA) has pledged a significant amount of state aviation infrastructure money to support this research program
- NASA will award two or more Collaborative Research Alliance Contracts in early 2001 based upon Proposal Competition
  - Late January NRA (~30 day response time)
  - Late Feb or early March 15 page Proposal Submission
  - Early April Award
- Details in this Presentation relate primarily to specific GMU research efforts
- Virginia Department of Aviation has requested that GMU lead the Virginia SATSLab Research Alliance
- The Research Approach outlined in this presentation by GMU is Proprietary and Competition Sensitive

HEF and POTOMAC Consolidated TRACON Airspace



Sources: FAA Potomac Consolidated\ TRACON Today's Airspace, 1999, and Flitesoft (RMS Technology, Inc.), 2000

HEF Flight Track Pattern



NASA Small Aircraft Transportation System

Southeast SATSLab Consortium

Seth Young and Ken Stackpoole

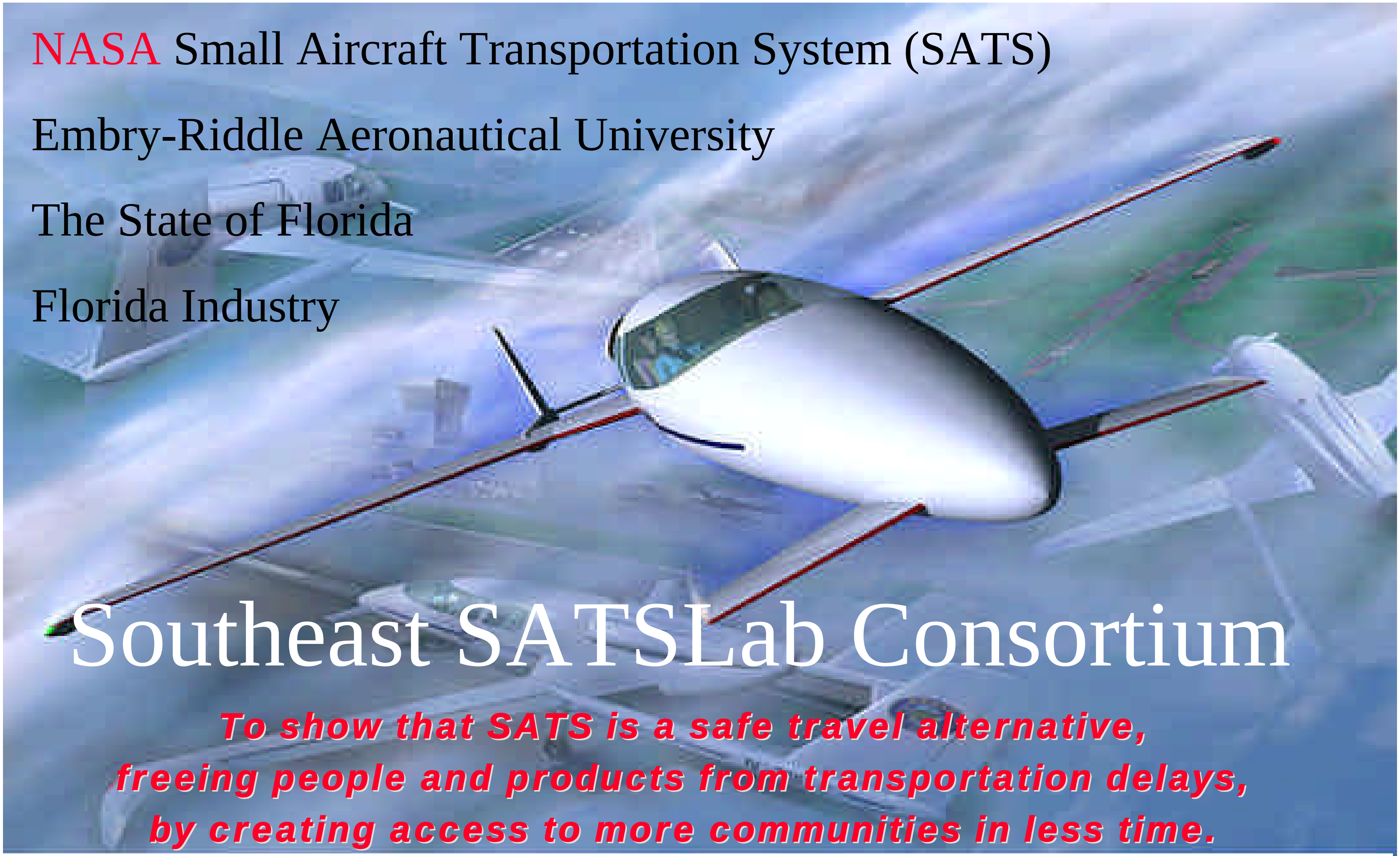
Presented at the 80th Annual Meeting of the:

Transportation Research Board

January 8, 2001 – Washington D.C.

Ken Stackpoole, 904-226-6123, stackpoole@db.erau.edu, http://sats.erau.edu

Small Aircraft Transportation System



NASA Small Aircraft Transportation System (SATS)

Embry-Riddle Aeronautical University

The State of Florida

Florida Industry

Southeast SATSLab Consortium

To show that SATS is a safe travel alternative,
freeing people and products from transportation delays,
by creating access to more communities in less time.

Small Aircraft Transportation System

NASA SATS Research Program

"Prove that the SATS Vision is Feasible"

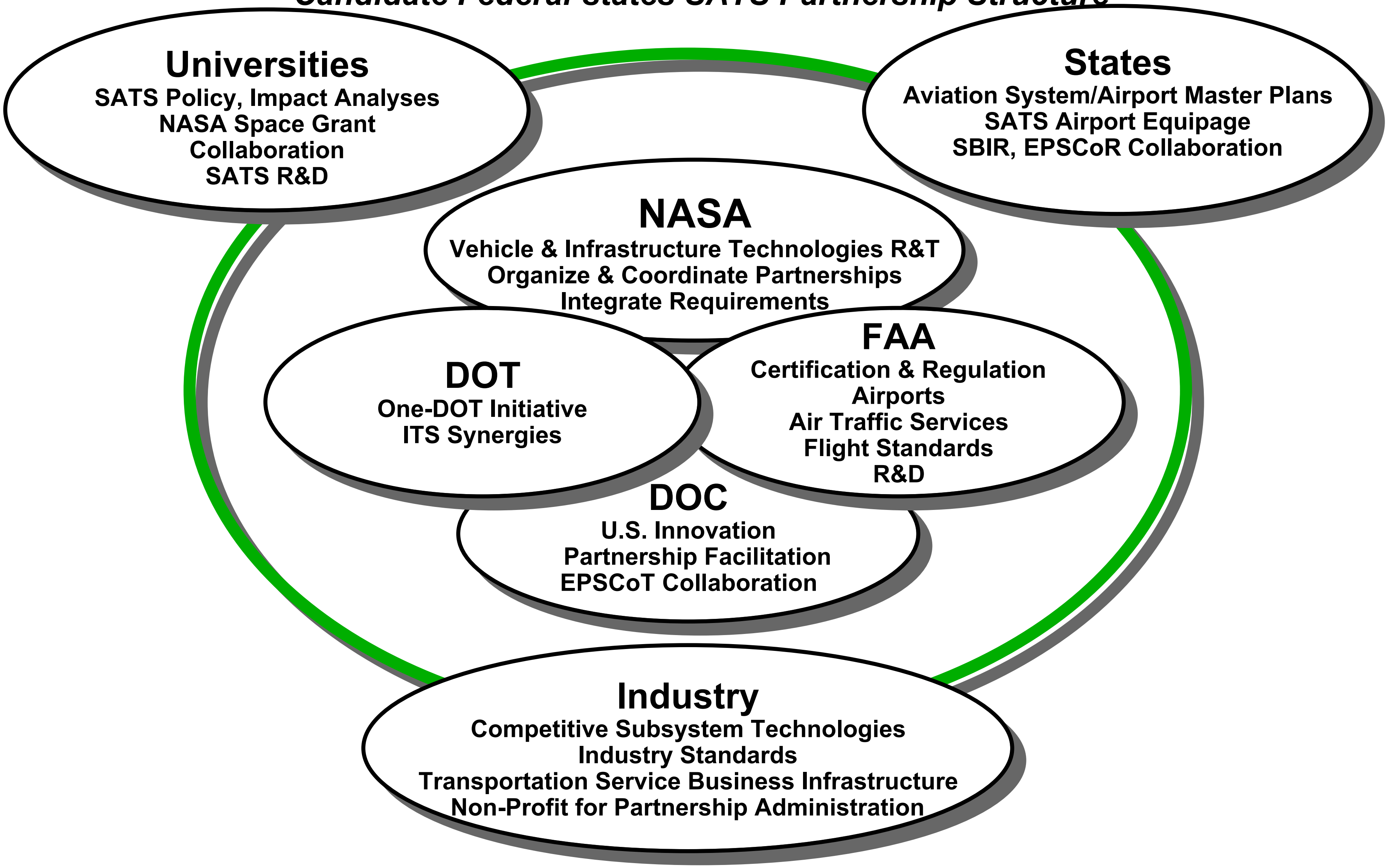
- Higher volume at non-towered, non-radar airports
- Lower Landing Minimum with less system cost in land, infrastructure, and facilities – (community acceptance)
- Reduced Flight Errors / Increased System Safety – (public acceptance)

Southeast SATSLab Consortium

Serve as the Southeastern States focal point for "Proof-of-Concept Demonstrations"

Small Aircraft Transportation System

Candidate Federal-states SATS Partnership Structure



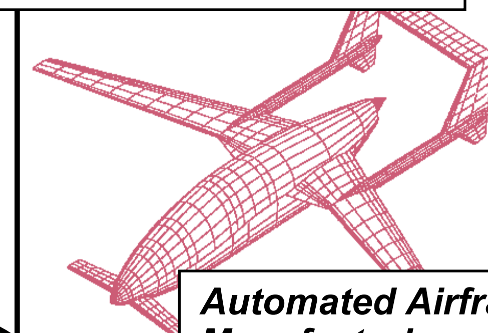
Small Aircraft Transportation System

Industry, Government, University Partnership

Requirements (Consumers and Providers)

“Smart” Information Age Cockpits

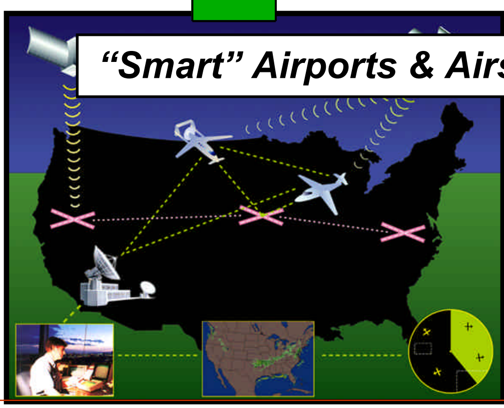
Clean & Quiet Propulsion Systems



Automated Airframe Manufacturing

Affordable and Profitable Alternative for our Communities, Businesses, and Travelers

“Smart” Airports & Airspace Infrastructure



Cyberspace Training

Adapted from Bruce Holmes, NASA GAPO, 1999

Industry Participation in the Consortium

1. Education and Training
2. Aviation Trades and Services
3. Aircraft Design / Manufacturing / Modification
4. Powerplant Design / Manufacturing
5. Avionics / Communication / Navigation / Surveillance
6. Airlines / Charter
7. Aviation Insurance
8. Air Traffic Management
9. Cargo / Small Package
10. Rental Car / Transportation Services

Government / Non-Profit Organizations

1. NASA
2. FAA
3. Florida DOT, Aviation Office
4. Enterprise Florida
5. Florida Aviation and Aerospace Alliance
6. Florida Space Grant Consortium
7. Florida Aviation Trades Association
8. Florida Airport Managers Association
9. University of Florida
10. University of Central Florida
11. Embry-Riddle Aeronautical University
12. City/County Chambers of Commerce
13. Airport Authorities
14. Economic Development Organizations

Additional Stakeholders required for full acceptance:

- insurance providers
- high schools and middle schools
- the non-aviation public – (friendly and non-friendly to aviation)
  - social/professional clubs and organizations
  - homeowners groups
  - airport environment groups
  - city/county councils

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EMBRY-RIDDLE AERONAUTICAL UNIVERSITY

Industry and Organizational Interest and Involvement

- Adam Aircraft Industries
- Aeronautical Solutions International
- Aircraft Owners and Pilots Association
- Air-Sur
- AON Risk Services
- ARNAV
- ATC Consulting Service
- Bay World Public Trust
- BF Goodrich
- City of Ormond Beach
- Eclipse Aircraft
- Embry-Riddle Aeronautical University
- Enterprise Florida
- FAA Tech Center
- FAA, Southern Region, Air Traffic Division
- FAA, Gainesville AFSS
- Federal Express
- Flightline Group
- Flitecard Corp.
- Florida Aviation Aerospace Alliance
- Florida Aviation Trades Association
- Florida Department of Transportation, Aviation Office
- Florida Institute of Technology
- Florida Space Grant Consortium
- Gainesville Council for Economic Outreach
- Gainesville Airport Authority
- Galaxy Aviation
- GE Harris
- Georgia Tech Research Institute
- Gleim Publications
- Global Navigation and Surveillance Systems, Inc
- GOAA, Air Cargo
- Greater Miami Aviation Association
- Greater Miami Chamber of Commerce
- Gulf Atlantic Airways
- Gulf Aviation
- Harris
- Hertz
- Honeywell
- Jakari Associates
- Jeppesen
- Lakeland Airport
- Leading Edge Aviation
- Legislative Consultants
- Melbourne Airport Authority
- Micco Aircraft
- Mod Works
- Morrow Aircraft Co.
- Munro Associates
- National Center for Simulation
- North Central Florida Safety Council
- Northrop Grumman
- Orlando Flying Club
- Passero Associates
- Peidmont Hawthorn
- Proton Aerospace
- Rannoch Corp.
- Real Estate Research Consultants
- Safire Aircraft
- Sebring Airport Authority
- Signature Flight Support
- SkyShare
- SMA, Rennault
- Southern Technologies Application Center
- Team Vision
- University of Florida, Aerospace Engineering Department
- University of South Florida, Department of Public Administration
- VB Aviation
- Wilbur Smith Associates

Education and Awareness / Organization of Stakeholders:

- Fall 1998 first letter to Florida Secretary of Transportation
- January 1999 – June 1999 – Presentations to various organizations
  - FDOT State Aviation System Planning Process Network of 9 CFASPP regions (airport managers, metropolitan planning organization reps, aviation consultants, AOPA rep, aviation public, Regional FDOT reps, local aviation entrepreneurs and businesspersons, FAA reps, Military reps, etc.)
  - Florida Airport Managers Association, Florida Aviation Trades Association, Florida Aviation & Aerospace Alliance, Florida Space Grant Consortium
- Organizational meetings of stakeholders – September 1 and October 8 - 1999 February 9, May 3, June 22, and October 4 - 2000.
- Incorporation of Southeast SATSLab Consortium – **September 28, 2000**
- Technical Operations Planning – September 15 and December 13 – 2000.

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Board of Directors

Executive Committee

Program Plan Working Groups

Technical Operations Planning

- Airborne Segment/Aircraft Technologies
- Ground Segment – Airside/Landside
- Operational Travel Scenarios
- Operations Center

Board Committees

- Education, Awareness, Membership
- Funding, Government Liaison
- Others as necessary

Southeast SATSLab Consortium Membership

Southeast SATSLab Consortium Objectives:

- Continue our education and awareness of SATS program
- Continue to recruit appropriate and interested stakeholders
- Participate in NASA's Technical and Research Objectives
- Demonstrations for the traveling public to "prove that SATS is a safe, affordable, and convenient option for intra-state/region travel requirement (300-1200 miles)"
  - Market Demonstration – provider/consumer participation
  - Economic Impacts – ROI for state, community, industry impact
- Demonstrate to the communities that relatively small investments in the new "smart" aviation infrastructure can provide affordable, reliable air service to their community airport.
- Let the Market Forces begin to take over

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Southeast SATSLab Consortium

Five Year Strategy – Program Plan

1. Select and outfit a network of airports with SATS technologies
2. Organize a fleet of aircraft equipped with SATS technologies
3. Develop seamless doorstep-destination connections at airports
4. Participate with NASA in Proof-of-Concept Experiments in 2003
5. Demonstrate Operational Travel Services in 2005
6. Resulting Network will be in place for initial Commercial Services
   - 2006 and beyond.

http://sats.erau.edu

Funding Sources

Federal Funding Sources:

1. NASA SATS Partnership Program Funds
2. Federal Research Grants

State Matching Sources:

3. Florida DOT Aviation Office R&D Funds
4. Florida Legislature/Governor's Office Program Initiatives
5. Airport infrastructure investments compatible with our Program Plan

Industry Matching Sources:

6. Southeast SATSLab Consortium membership fees and dues
7. Consortium Industry Member Participation in Program Plan
8. Venture Capital

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Southeast SATSLab Consortium

Target Dates

2003 – Proof of Concept Experiments (POCX)

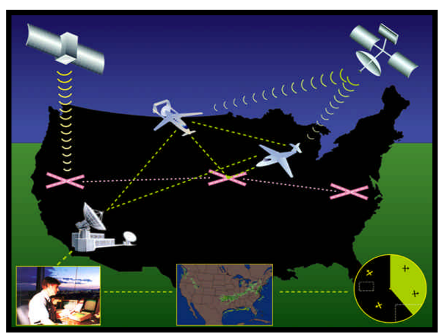
Focus on **operational feasibility**

2005 – Showcase Demonstrations (SD)

Focus on **market feasibility**

2003 – Proof of Concept Experiments: **Operational Feasibility**

- Available & Reliable Aircraft and Avionics Capabilities
- Available Communications & Information Infrastructure
- Available Approaches in varying environments



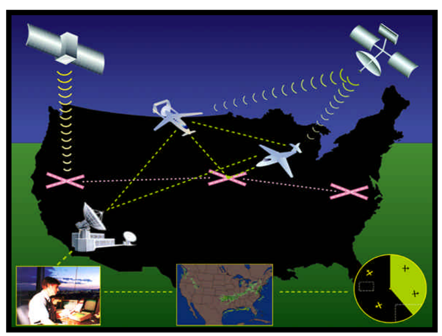
Small Aircraft Transportation System

Availability: Technology operational to allow precision approaches to SATS airports in nearly all weather conditions.

- Rural, Non-Towered Airports
- High volume traffic areas
- Various Airfield Layouts
- Various Precision Approaches

2003 – Proof of Concept Experiments: **Operational Feasibility**

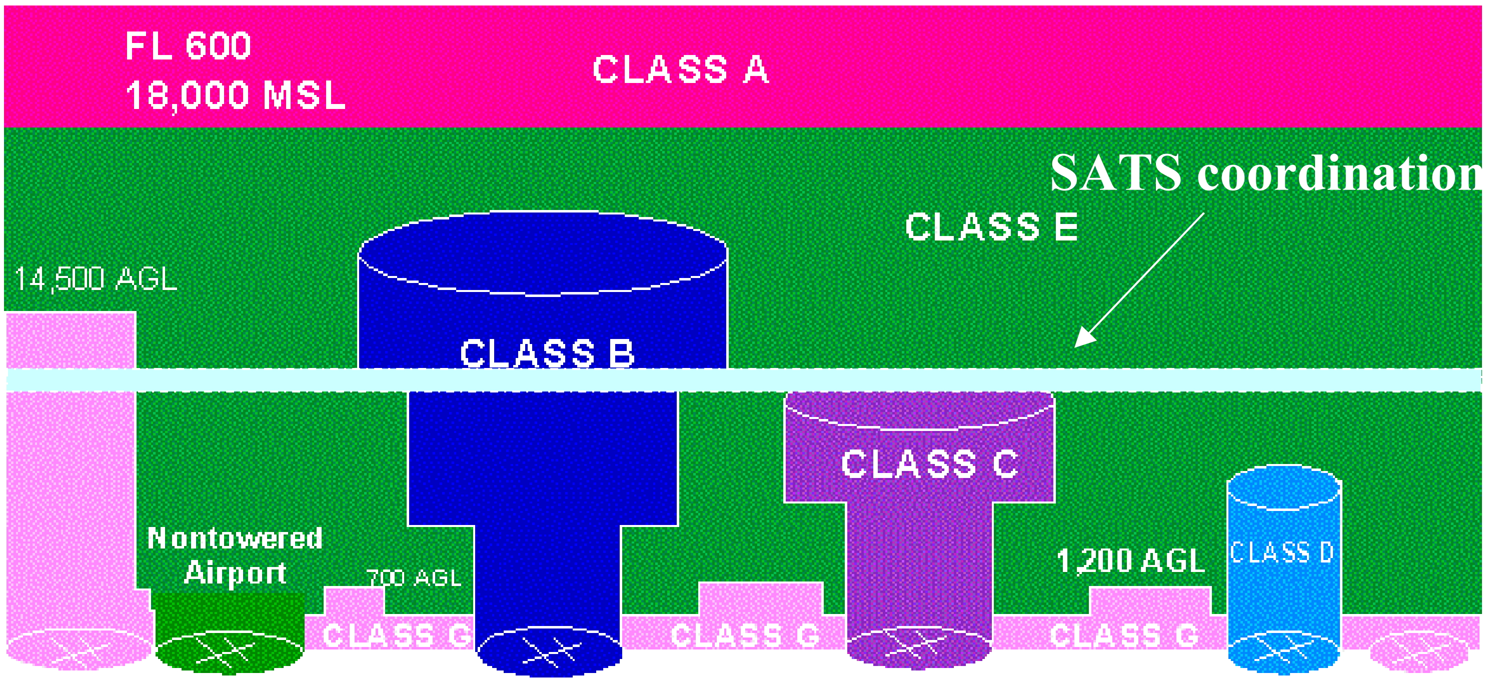
- Available & Reliable Aircraft and Avionics Capabilities
- Available Communications & Information Infrastructure
- Available Approaches in varying environments
- Available Terminal and Ground Access facilities

Small Aircraft Transportation System

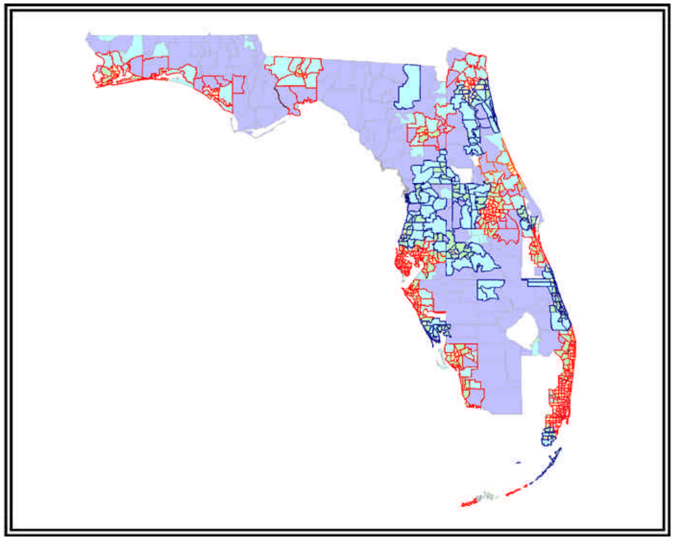
2003 – Proof of Concept Experiments: **Operational Feasibility**

Compatible with current N.A.S. and A.T.C. Procedures



2003 – Proof of Concept Experiments: **Operational Feasibility**

System Accessibility: SATS airports located within tolerable proximity of passenger and cargo origins and destinations.



- Within 30 minutes of rural & suburban communities.
- Centrally located within urban areas.

2003 – Proof of Concept Experiments: **Operational Feasibility**

Accessibility: Available intermodal access to SATS portals

2003 – Proof of Concept Experiments: **Operational Feasibility**

SATS System provides preferable service where there is sufficient market demand between points of origin and destinations.

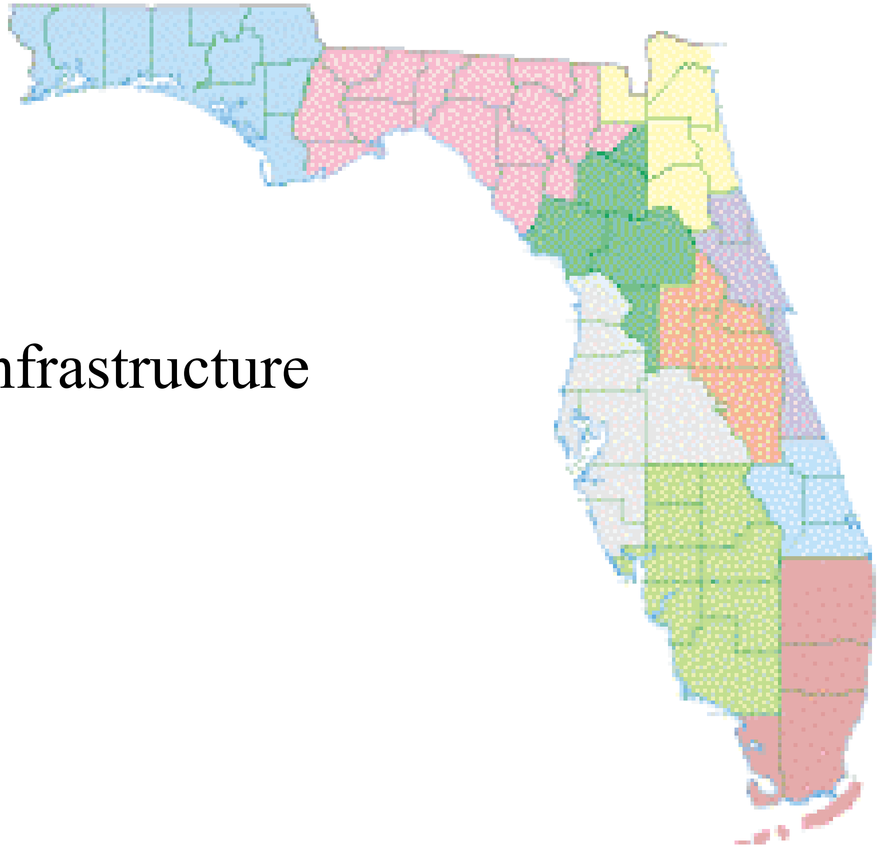
Three operating scenarios:

1. Single / Multi Destination, one-day business trip – Time Critical
2. Family leisure trip – Convenience Critical
3. Small cargo operations – Time, Convenience, Reliability Critical

Small Aircraft Transportation System

2003 – Proof of Concept Experiments: **Operational Feasibility**

Immediate Tasks of Consortium

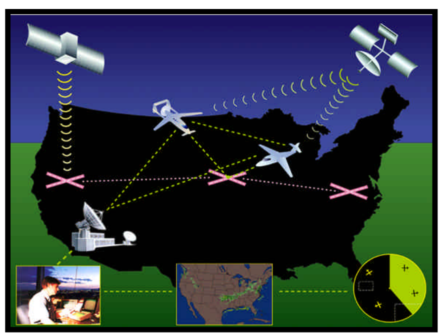


- Select initial SATS test markets
- Activate & Develop operational infrastructure
- Coordinate with N.A.S. / A.T.C.
- Develop Market Awareness
- Involve Community Support

Small Aircraft Transportation System

South East SATS Lab Working Groups: 12/13/2000

- Airborne Segment / Aircraft Technology Group
- SATS Operations Center
- Ground Segment – Airside / Landside Group
- Operational Travel Scenarios Group

NASA Aerospace Technology Enterprise
Small Aircraft Transportation System

Workshop Products

SATS Planning Workshop
Omni - Newport News, VA
January 23, 2001

Figure 1

Putting the "Work" in Workshop

- **Ideas - This is the key product**
- **Ideas - That can help NASA define a program "roadmap" for the next 5 years**
- **Ideas - Discussion of the objectives and challenges that must be met/overcome to demonstrate key operating capabilities**

NASA SATSLab 5 Year Program

5 Year Goal

Higher-Volume Operations
in Non-Radar Airspace at Non-Towered Facilities
(Expansion of Capacity)

Objectives ***(NAS Benefits)***

- Separation Assurance
- Collaborative Sequencing
- Conflict Detection & Resolution
- Dynamic Approach Paths

Technical Challenges & Issues

- Accurate A/C Position
- Information/Data Fusion
- Validation of Complex Software
- Systems Integrity
- Communications

Figure 3

Operating Capability Objectives

- Integrated flight control and display system
- Automation and pilot monitoring systems
-
-
-
-

Figure 4

Technical Challenges

- Providing precise control of the vehicle flight path
- Providing situational awareness during low-visibility conditions
-
-
-

Other Issues

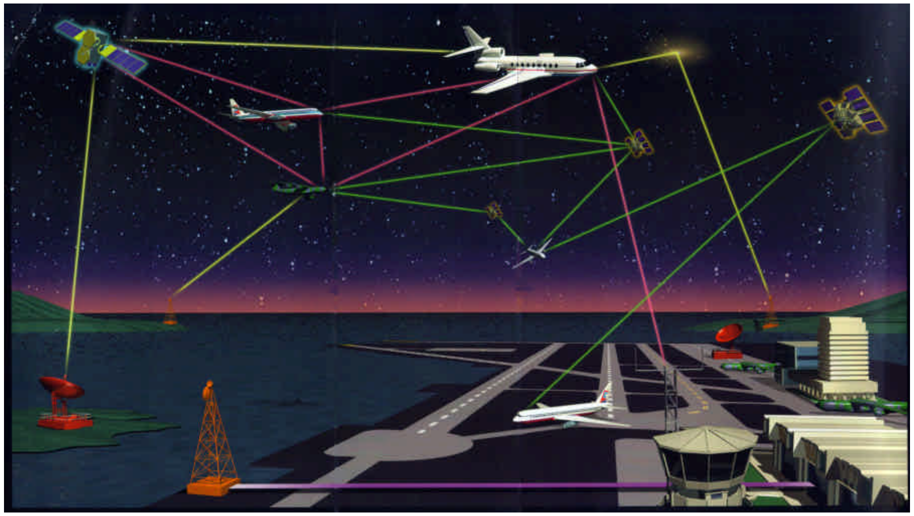
- Is there a need for transition from internal to external reference
- Cost of ground based infrastructure versus airborne technologies
- Wrong metrics and/or success requirements
-
-

Figure 6

Higher Volume Operations at Non-Towered/Non-Radar Airports

Simultaneous operations by multiple aircraft in non-radar airspace in near all-weather conditions at and around small non-towered airports can create increased mobility and accessibility across the nation.

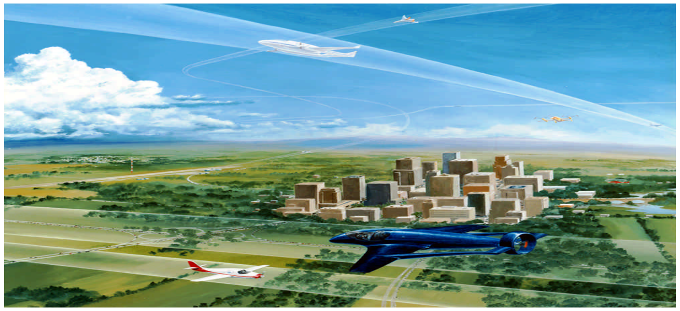
Outcome: Increased NAS Capacity



Courtesy of Rockwell Collins

Key Enabling Technologies:

- **Airborne internet communication standards and protocols for client-server communications and functional allocations**
- **Algorithms for self-sequencing and separation**
- **Enhanced (Artificial/Synthetic) Vision**



Flight Systems for Improved Total System Performance

Human-aided automation will provide intuitive, easy to follow flight path guidance superimposed on a depiction of the outside world. Photo-realistic database terrain will be graphically integrated with mm-wave radar-sensed terrain. Software enabled flight controls and flight planning will increase single-pilot operational safety, mission reliability, and Total System Performance (TSP) to ATP-like levels.

Outcome: Increased NAS Throughput

Key Enabling Technologies:

- **Enhanced (Artificial/Synthetic)Vision**
- **Highway-In-The-Sky 4D Guidance**
- **Software-Enabled Controls (Envelope Limiting, simplified attitude/speed coupling)**
- **Emergency Autoland**

Figure 8

Lower Landing Minimums at Minimally Equipped Landing Facilities

Runway Protection Zones for Highway in the Sky flightpath guidance can create near all-weather access to any touchdown zone at any landing facility while avoiding:

- **Land acquisition costs**
- **Approach lighting costs**
- **Ground-based precision guidance systems (ILS) costs**
- **Radar and control tower infrastructure costs**

Outcome: Reduced Cost of NAS Expansion

Key Enabling Technologies:

- **Enhanced (Artificial/Synthetic)Vision**
- **Highway-In-The-Sky 4D Guidance**
- **Software-Enabled Controls (Envelope Limiting, simplified attitude/speed coupling)**
- **Emergency Autoland**

Runway Protection Zone (RPZ)

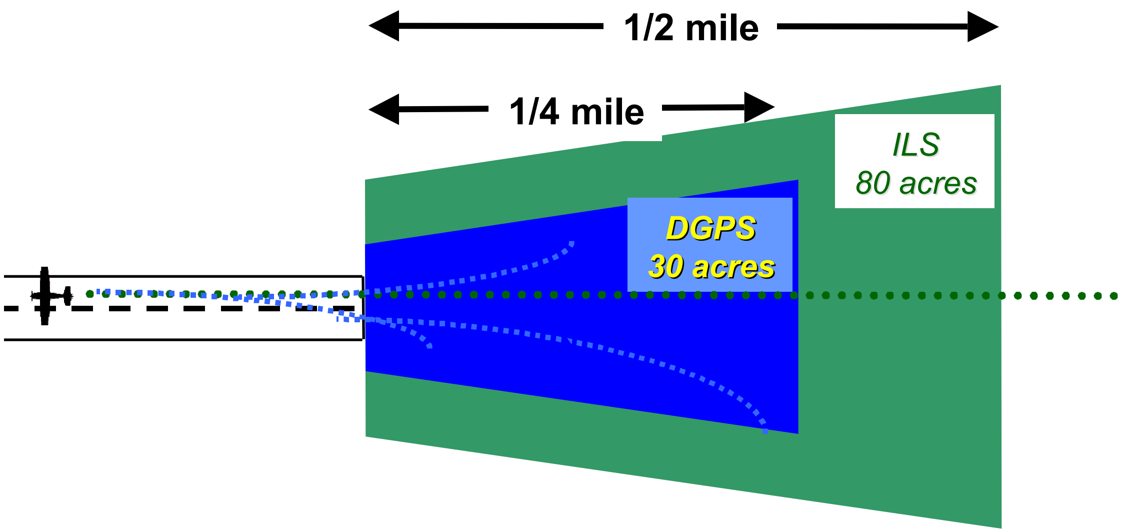


Figure 9

SATS Technical Workshop

January 24, 2001

Team C O W

Higher Density Operations (HDO) Operational Capabilities

- Precision Integrated 4D Traffic, Hazardous Wx, Terrain, Obstacle/Structure Location (Information Fusion)
- Arrival and Departure Sequence Negotiation
- Fail-Operational/Fail-Safe Provisions in Aircraft and Ground Systems (Fault Tolerance)
- Dynamic Terminal Approach Procedures (DTerPs)
- Runway Incursion Detection

Higher Density Operations (HDO) Operational Capabilities (Concluded)

- 4D Approach Following
- Autoland
- Inflight Flight Plan Amendment
- New Certification Guidelines for Displays & Symbology
- Revamped Pilot/Operator Training & Certification Processes

Higher Density Operations Technical Challenges

- Dynamic Flight Rules Development (e. g. DTerPs)
- Hazardous Wx Detection/Prediction at Required Granularity and Currency
- Reliable Conflict Detection and Resolution
- Reliable Detection of Primary Targets
- Runway Incursion Detection Adequacy

Virtual Visual Meteorological Conditions (VVMC)
Operational Capabilities

- Active Controls for T-Storm Penetration
- Aircraft and Airspace Envelope Protection
- Autoland
- Autopilot-Autothrottle

Virtual Visual Meteorological Conditions (VVMC) Operational Capabilities (Continued)

- Curved Dynamic Approach Generation (DTerPs)
- Direct Pilot/Operator Control of Aircraft Velocity Vector
- Envelope & Obstacle Protection (e. g. HAZ Wx, Terrain, Cows)
- Guidance Compatible with Approach Minimums

Virtual Visual Meteorological Conditions (VVMC) Operational Capabilities (Continued)

- Icing Protection
- Intuitive Controls and Displays (e. g. HiTS, MFD, SLPC, Flight Velocity Vector Controller)
- Intuitive, Human Factors Engineered Displays for Vehicle Control (e. g. Abstract vs. Photorealistic)
- Low Cost Fly-By-Wire

Virtual Visual Meteorological Conditions (VVMC) Operational Capabilities (Concluded)

- Precision Integrated 4D Traffic, Hazardous Wx, Terrain, Obstacle/Structure Location (Information Fusion)
- Precise & Timely Hazardous Wx Information
- Reliable, Intuitive, and Comfortable Cues for Transition to Visual
- Runway Incursion Detection

Virtual Visual Meteorological Conditions (VVMC) Technical Challenges

- Approach/Landing Coupling to Flight Control System
- Development of Certification Guidelines
- Development of Envelope Protection
- Development of Low-Cost Elements (e. g. Fly-by-Wire, Fault Tolerance, Information Fusion,
- Development of Direct Pilot/Operator Control of Aircraft Velocity Vector

Virtual Visual Meteorological Conditions (VVMC) Technical Challenges (Concluded)

- Demonstration of Certifiability
- Fault Tolerant Designs
- Fusion of Hazardous Wx, Traffic, and Terrain Information
- Human Factors Engineering for Cognitive Tasks as Well as Ergonomics
- Propulsion System Reliability

Total System Performance (TSP) Operational Capabilities

- Autopilot – Autothrottle
- Cockpit and Flight Comfort (Ergonomics & Flight Dynamics)
- Direct Pilot/Operator Control of Aircraft Velocity Vector
- Approach/Landing Coupling to Flight Control System

Total System Performance (TSP) Operational Capabilities (Concluded)

- Envelope and Obstacle Protection (e. g. HAZ Wx, Terrain, Cows)
- Intuitive Controls & Displays (e. g . HiTS, MFD, SLPC, Velocity Vector Controller)
- Pilot/Operator Decision Aids

Total System Performance (TSP) Technical Challenges

- Affordable Reliability
- Automated S/W Certification
- Development of Low-Cost FBW
- Development of Envelope Protection

Total System Performance (TSP) Technical Challenges (Concluded)

- Fault Detection, Display, Tolerance
- Human Factors for Cognitive Tasks (Cognitive Ergonomics)Leading to
  - Optimized Pilot/Operator Workload
  - Reduced Pilot/Operator Stress Level
- Wx Support System Adequacy/Maturity

Transcending Issues

- Affordability – Low Cost Elements (e. g. Aircraft TOC, Training & Certification, Infrastructure)
- Alternative Fuel Availability & Affordability
- Appropriate Hardware & Software Certification Guidelines
- Automated Software Certification

Transcending Issues (Continued)

- Credible & Comprehensive Benefit/Cost Analysis
- Credible Estimates of ROI for Stakeholders
- Datalink and Data Compression Availability & Adequacy
- Demonstrable Certifiability
- Fault Tolerant Designs – Fail Operational/Fail Safe

Transcending Issues (Continued)

- Highly Reliable Air & Ground Elements
- Human Factors Engineering for Cognitive Tasks As Well As Ergonomics
- Improved Cockpit and Flight Comfort
- Interoperability with NAS & Mixed Equipage Operations (Fleet & Ground Facilities)

Transcending Issues (Concluded)

- Minimal Human Intervention Consistent with Safety, Sound Human Factors Engineering, and User Acceptance
- Outreach & Education Needed to Maximize SocioPolitical Acceptance
- Reasonable Liability Limits (Insurance & Legal)
- Resolution of Competency vs. Interest Profiles in Potential Stakeholders
- Revamped Pilot/Operator Training & Certification Process

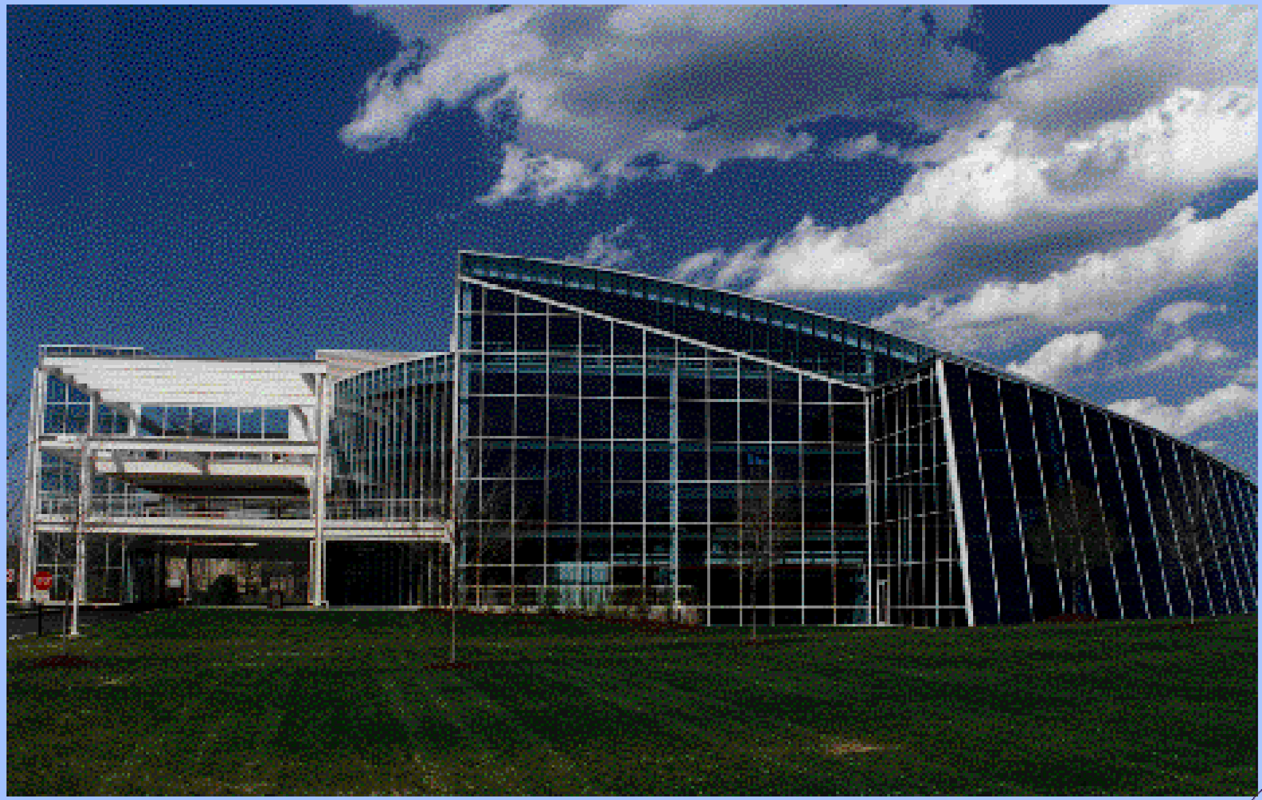
Enroute - SATS Integration with NAS

- Separate the Issues
  - Aircraft Equipage Transition
  - Pilot Experience
  - Aircraft Performance

Team Name

Comprehensive Operations Workgroup?

OAI



OAI

SATS Team Two

Paul F.

Jim R.

Bill R.

Pete Mc.

Seana G.

Ed F.

Dan Y.

Dan D.

Pete P.

Kathy M.

Bob M.

Anthony W.

Bob W.

Scott F.

Steve T.

Ted B.

Frank P.

Team Two - ***Higher Volume Operations at Non-Towered/Non-Radar Airports***
Operating Capability Objectives

- Information Delivery System - Intuitive Traffic Info or display - (Total Picture or Local Display?)
- Evasion Capability
- Operate >1 aircraft within terminal area in IMC without ATC procedural separation
- Auto/Self Sequence &Separation
- Grandfathering to Existing/Future ATC
- Classless airspace?
- Mix of VFR & SATS operations without tower - raise threshold or eliminate FAA requirement for tower
- Common framework/standards

OAI

Team Two - ***Higher Volume Operations at Non-Towered/Non Radar Airports*** - Challenges

- Integration of mixed flow IFR - VFR - SATS
- Manufacturer Buy-in
- Accommodate existing fleet (retrofit)
- Insurance - SATS must be as safe or safer
- Fail-safe
- Independence from ATC services becoming dependence on info systems
- Intuitive situational awareness
- User perceived benefit

OAI

Team Two - ***Flight Systems for Improved Total System Performance*** - Operating Capability Objectives

- Auto land - auto flight (precise energy management)
- Simple Nav, Flight controls, Comm, etc - 1 button
- Low capability single pilot in IMC or VMC performance equivalent to 2 pilot professional crew
- Help button
- Password protection for SATS pilot certification level
- Multiple levels of redundancy
- Reversionary back-up
- Few pilot decisions
- Crash protection
- Equipment self-diagnosis
- Automated pre-flight
- Pull-over

OAI

Team Two - ***Flight Systems for Improved Total System Performance*** - Challenges

- Lesser capability pilots with higher performance
- Automated flight planning
- VMC IMC independent
- Training - cirriculum
- Standardized aircraft - performance, instrumentation
- Automation
- Fail-safe
- Real time non-controlling oversight
- Decision help

OAI

Team Two - ***Lower Landing Minimums at Minimally Equipped Landing Facilities***

Operating Capability Objectives

- Location - Position - Precision Guidance
- Obstacle and terrain knowledge
- Automatic course calculation - Dynamic approach & departure paths
- Uplinked local & destination weather, runway & local info (addressed elsewhere)
- Obstacle detection, inflight NOTAM
- Dynamic missed approach, alternate - Automatic alternate flight planning
- Slower aircraft
- Auto taxi

OAI

Team Two - ***Lower Landing Minimums at Minimally Equipped Landing Facilities***

Challenges

- Reduced pilot workload
- Certification
- Liability
- Fail-safe
- Situational awareness
- Airport standards

Team Two - ***Other Issues***

- Fractional ownership
- Is SATS Infrastructure or Vehicle-centric?
- Pilot vs. highly automated Operator philosophy
- Statutory liability cap or tort reform
- SATS “for hire” operations - differing certification levels and medical requirements?
- Who’s in charge?
- Proof Of Concept pilot flown approach
- Mission profile

Team Three - ***Higher Volume Operations at Non-Towered/Non Radar Airports***

Operating Capability Objectives

- SATS - to function in mixed operations - IMC, VMC
- Equipment & Pilot Requirements need to be matched
- Ancillary Services/Intermodal tie-in
- The NAS and SATS must coexist
- SATS must display position of all aircraft in immediate environment

Team Three - ***Higher Volume Operations at Non-Towered/Non Radar Airports*** - Challenges

- Automatic Sequence & Separation Assurance
- Common Situational Awareness (Aircraft, Weather, Terrain)
- Pilot Workload - Human Factors/Computer Human Interface f(speed, separation, # of aircraft)
- Ground Systems Requirements
- Radio Spectrum Availability, Effectiveness

Team Three - ***Flight Systems for Improved Total System Performance*** - Operating Capability Objectives

- Intuitive Interface that motivates the pilot, requires no learning
- Guaranteed Flight Technical Conformance
- Communicate/Update pilot intentions
- Pilot Workload reduction systems
- Develop adequate standards & requirements

OAI

Team Three - ***Flight Systems for Improved Total System Performance*** - Challenges

- Human Interface
- Frequency Spectrum availability
- Navigation system accuracy and performance
- Costs

Team Three - ***Lower Landing Minimums at Minimally Equipped Landing Facilities***

Operating Capability Objectives

- The Team recommended a cost-benefit look at this area because they believed it had a low priority for SATS
- Industry is already solving the problem between 250 - 600 feet.
- May be redundant as it would require the same technology as *Higher Volume Operations at Non-Towered/Non-Radar Airports*

OAI

TEAM THREE - ***Other Issues***

- Program must be agile and practical to avoid being too late to be useful
- Icing
- NAS mixed operations an essential feature of SATS
- The low landing minimums might be a low benefits/high risk activity: better to address enroute interface
- Efforts in developing human interface inadequately presented in SATS plan
- Pilot role/responsibility needs to be spelled out
- Insurance and system cost need to be addressed

OAI

Industry Expert Team

Tom Ippolite	MADL
Mary Beth Lapie	Rockwell Collins
Tom Glista	FAA-Flight Standards
Ron Swanda	General Aviation Manufacturers Association
Mike Liester	Oklahoma Aeronautical & Space Com.
Andy Supinie	Cessna Aircraft Company
Tom Menzies	Transportation Research Board
Gregg Schneider	Dynamic Systems Integration
Mike Zernic	NASA Glenn Research Center
Howard Swingle	Virginia Tech
Gaudy Bezos O'Conor	NASA LaRC
Brian Hayes	United Airlines
Tom Freeman	NASA LaRC
Dave Grieco	Munro and Associates

Operating Capability Objectives

High Volume Operations:

- Demonstrate capability with flyable hardware/software by 2003; on route and in terminal (self separation and self sequencing).
- Combined hardware/software/training should improve performance in reducing Total System Errors.
- Quantifiable benefits vs. cost analysis: How will it be incorporated and what does it buy.
- Compatible with radar and non radar environments
- Evaluate logic of automatic flight management system
- Define minimum acceptable performance and inter-op for CD & R and self separation

Technical Challenges

High Volume Operations:

- Smart plane versus human intervention
- Automation versus training – what skill level is needed, what should the balance be.
- Quality of training needs to be maintained.
- Develop 4D (x,y,z, time) communication/negotiation capability… planes talk via some medium, must be interactive, real time.
- Determine hardware, software, sensors standards for POC
- Standards for automated flight management
- Datalink compatibility versus cost versus performance (plane – plane – ground)

Operating Capability Objectives

Total System Performance:

- Determine optimal scene content for display
- Determine requirement for run way projection zone, 20:1
- HITS display meets 20:1
- Inclusion of automated flight controls
- Evaluate various configurations for flight control (manual….fully automated)
- Demonstrate coupling of auto pilot approach and transition to visual landing.

Technical Challenges

Total System Performance:

- Maintaining databases for terrain and obstacles
- Tradeoffs for TSP improvement (cost/benefits)
- Determining appropriate level of sub system reliability
- Mitigation of pilot risk taking
- Low cost HUD for GA

Operating Capability Objectives

Lower Landing Minimums:

- Develop and demo Virtual TERPs
- Determine maximum acceptable maneuvering during an approach.. How much ‘straight in’ is required.
- Determine preferred minima
- 500-2 is minimum and 300-1 is the goal
- Cost versus benefit analysis of 500-2, system wide and cost of incremental minimum decrease.
- Collect and record weather data to get minimums across USA
- Insure human factors are considered and implemented in design.
- Demo decision aid for weather and traffic.

Technical Challenges

Lower Landing Minimums:

- Aircraft system design that allows for stable/steeper approaches
- Sensors for enhanced vision; reliability and cost
- Development of Virtual Terps
- KISS… pilot interaction with display and operation
- Cheap, automated weather reporting to aircraft
- WAAS integrity and availability

Other Issues

High Volume Operations:

- Who is liable in non controller separated air space
- How do we shift from positive control environment to open environment
- Flight independent of ground element (architecture question)
- POC operable in SATS and NAS environment ? How to integrate into NAS
- FAA plan on how to incorporate HVO into ongoing NAS research

Other Issues

Lower Landing Minimums:

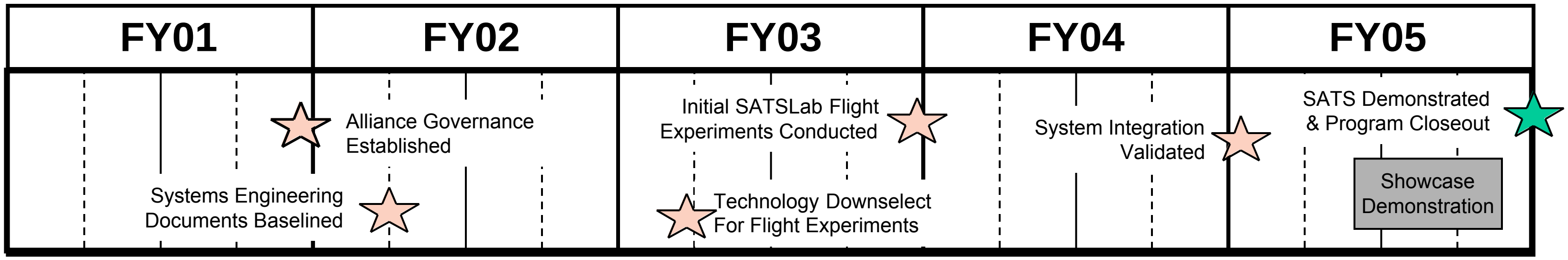
- FAA approval of Virtual TERPS
- Precision approach MSR
- Viability and necessity of auto land
- Explore auto approach as possibility
- How much automation to provide optimal capability and system performance
- Name (SATS) does not represent true goals of this program (small airport/smart aircraft)
- Relevance of enhanced vision versus synthetic vision

Feedback & Comments

SATS POCs

- **General questions, program plan, & planning process**
  - Dave Hahne, D.E.Hahne@larc.nasa.gov, ph. 757-864-1162
- **FAA**
  - Pete McHugh, P.C.Mchugh@larc.nasa.gov, ph. 757-864-8490
- **Technology Integration & Flight Demonstrations**
  - Jim Burley, J.R.Burley@larc.nasa.gov, ph. 757-864-2008
- **Systems Analyses & Assessment**
  - Stuart Cooke, S.A.Cooke@larc.nasa.gov, ph. 757-864-7087
- **Virtual VMC**
  - Ken Goodrich, K.H.Goodrich@larc.nasa.gov, ph. 757-864-4009
- **High-Density Ops**
  - Peter Padilla, P.A.Padilla@larc.nasa.gov, ph. 757-864-6187
- **Alliance Business Planning**
  - Gaudy Bezos-Oconnor, G.M.Bezos-Oconnor@larc.nasa.gov, ph. 757-864-5083
- **Public Outreach & Education**
  - Liz Ward, E.B.Ward@larc.nasa.gov, ph. 757-864-7638

SATS Demonstrated & Program Closeout



Milestone Description

Demonstrate the level to which the Small Aircraft Transportation System concept is feasible. Complete program documentation and closeout activities.

Exit Criteria

– Provide the technical, policy, and economic basis for national investment decisions to develop the Small Aircraft Transportation System concept including:
  - Complete a cost modeling analysis that validates affordability of concept.
  - Complete 2005 public demonstration of concept features and capabilities.
  - Identify changes needed in regulations, certification procedures, and airport/airspace design to enable the concept.
  - Measurement of latent market potential.

– Program documentation completed.

SATS Showcase Demonstrations

- **Goal**
  - Enable future policy and investment decisions by local, state, and federal stakeholders regarding SATS
- **Objectives**
  - Conduct flight evaluations of an integrated set of enabling technologies that illustrate the operational capabilities and their impact on a variety of end-user mission scenarios
  - Present systems-level benefits derived from detailed simulations, flight experiments, economic analyses, and end-user assessments that address mobility, accessibility, capacity, and economic metrics as well as social and environmental implications
- **Stakeholders**
  - Federal transportation policy makers i.e., DOT, FAA, key congressional members, etc.
  - State transportation directors, economic development authorities, aeronautics directors, airport managers, etc.
  - Local community economic development managers, local airport owners and operations, FBOs, etc.

SATS Showcase Demonstrations

- **Approach**
  - Utilize NASA, FAA, State, Industry, and University assets (Alliance) to conduct several major showcase demonstrations in strategic locations that maximize stakeholder exposure to SATS operational concept,capabilities, and benefits
- **Requirements**

‘05 Flight Demonstrations

- ConOPS, mission scenarios (subset)
- Functional Requirements (subset)
- Systems architecture
- Federal, state, and local approvals for flight demonstrations
- Flight Operations and coordination with FAA/ATC
- Public Outreach and Education

Systems Analyses - SATS end state

- ConOPS, mission scenarios
- Functional Requirements
- Systems architecture
- Systems engineering process for metric assessment
- Metrics identification
- Public Outreach and Education

Discussion Points

- **'Airborne Internet'**
  - high bandwidth (megabit?) communications system that enables aircraft-to-aircraft and aircraft-to-ground collaborations thus minimizing (eliminating) conventional ATC communications

- **Flight Evaluations**
  - '05 system architecture different from final 'end-state' architecture - safety-of-flight, system integrity, technology maturity, etc.
  - Level of participation by stakeholders in the flight evaluations?
  - Scope of flight demonstrations? ...mission complexity & fidelity, number and type of aircraft, robustness, etc.
  - Intermodal connectivity? How much of the commercial end-state can be demonstrated in '05 even though there is no market (yet)?

Discussion Points….concluded

- **Systems-level Benefit Analyses**
  - What metrics best capture the SATS concept and at the same time allow for comparisons with other modes of transportation?
  - What level of fidelity is needed to assess system performance in order to convince stakeholders? Can we afford it?
  - Future market potential - how do we begin to capture this recognizing that travel preferences will likely change as a result of SATS?
  - What are the perceived barriers to SATS in the minds of the general public? Can we overcome them through public outreach and education?

SATS Partnering Status

SATS Partnership Design Team (SPDT)
SATS Technical and Partnering Workshop
1/23-24/01

SATS Partnering Objectives

- Form a collaboration between NASA and a single public-private program interface (SPPPI) to achieve the SATS Program's technology development, technology transfer and commercialization objectives.

- As NASA's single business collaborative partner:
  - Represent their membership in the coordination, technology demonstration, and implementation of the SATS program
  - Be responsible for partnership administration and non-federal technical task management
  - Engage state and local aviation authorities coordinating SATS program tests at various locations
  - Lead the self-organization of the GA manufacturers, suppliers, users, service providers, financial and insurance providers

SATS Partnering Timeline

Nov 2, 2000	RFI announcement
Dec 8, 2000	RFI response date
Jan – Feb 2001	Analysis of RFI inputs (Jan) Summary of RFI inputs (2/05 web posting) Technical and partnering workshops Selection of partnering mechanism (Feb)
Mar – Apr 2001	Draft of partnering solicitation
May 2001	SATS single public-private interface solicitation process begins
Aug 2001	SATS single public-private interface in place

Federal Technology Projects
PARTNERSHIP ANALYSIS
A Brief Comparative Review

Presented to: SATS Workshop

January 24, 2001

Presented by: STARNet, LLC

Keith Gale

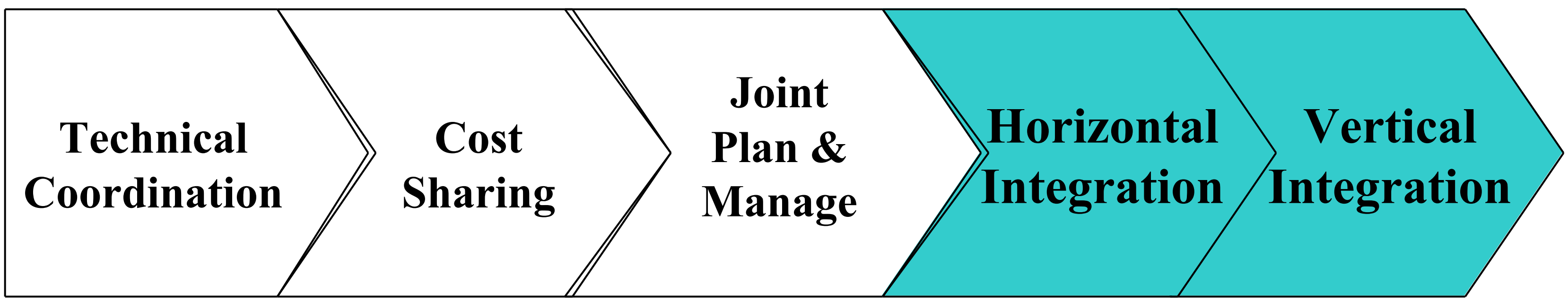
STARNet

PRESENTATION STRUCTURE

- PARTNERSHIP SPECTRUM
- PARTNERSHIP ATTRIBUTES
- GENERIC ORGANIZATIONAL CHART
- EXAMPLE: AGATE ORGANIZATION CHART
- TWO COMPARABLE ALLIANCES
  - Sematech
  - Amtex

PARTNERSHIP SPECTRUM

- **The universe of Public/Private Technology Partnerships spans a broad range of practices. At a minimum, the practices include the following:**



This presentation will focus only representatives from the last two

PARTNERSHIP ATTRIBUTES

An alternative to Spectrum Analysis

LIST OF ATTRIBUTES
Purpose of Partnership
Nature of the Industry
Goals of Partnership
Membership and Structure
Funding and Legal Vehicles
Working Arrangements
Accountability
Life Cycle

Comparative Analysis

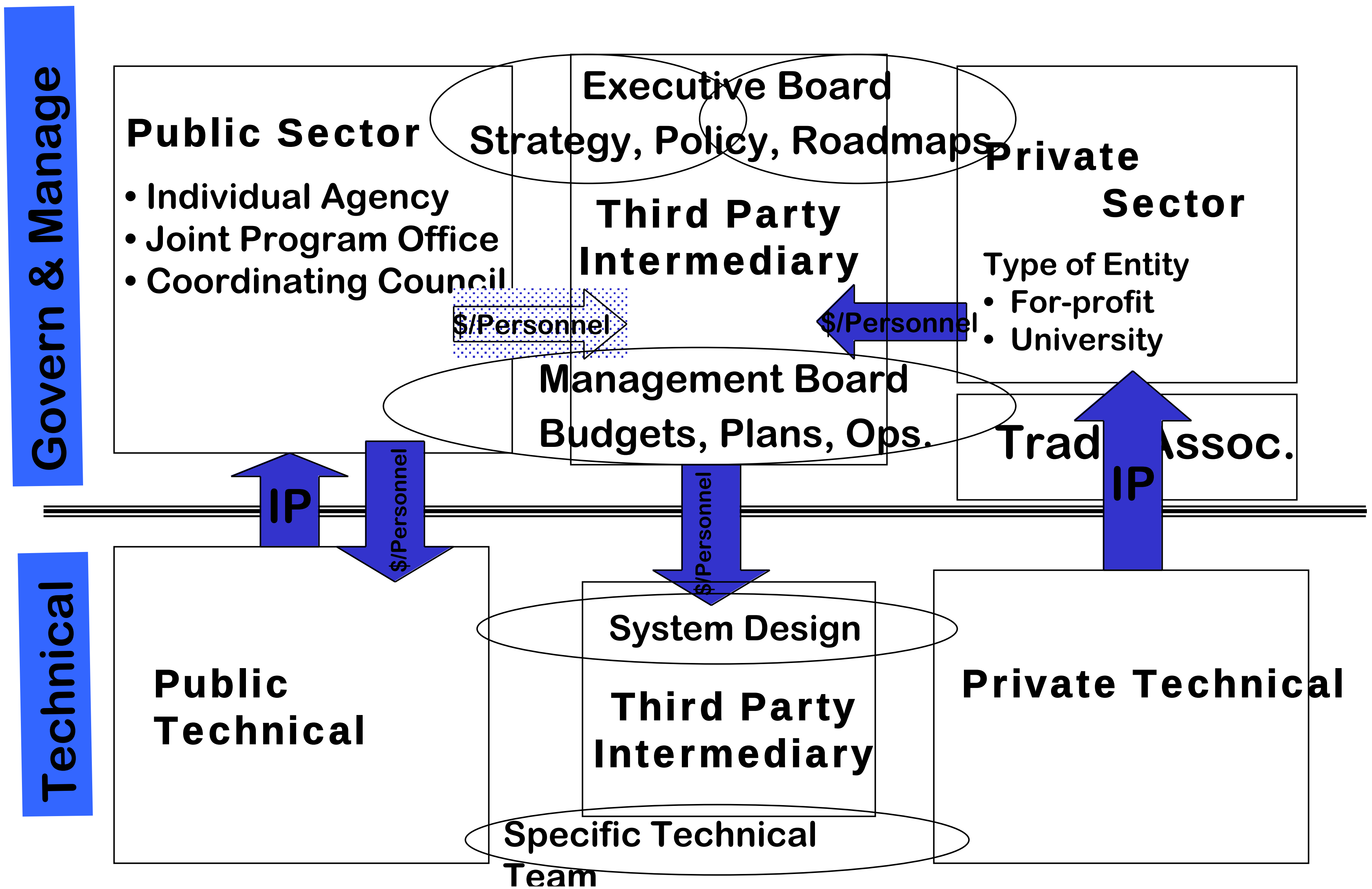
Structured Finding Format

Joint planning	Did Partnership create at least one level of management team with representatives providing input?
Joint funding	Were real dollars (not just in-kind) being contributed? What were the source of those dollars (i.e.-private sourcing, not federally-derived)
Co-management	During implementation, did each party contribute time and effort to operate?
Use of Non-profit, intermediary	Was a central entity used, not necessarily a separate legal entity?
Systems technology development	If the scope of the partnership warranted, was there an attempt to create a system design?

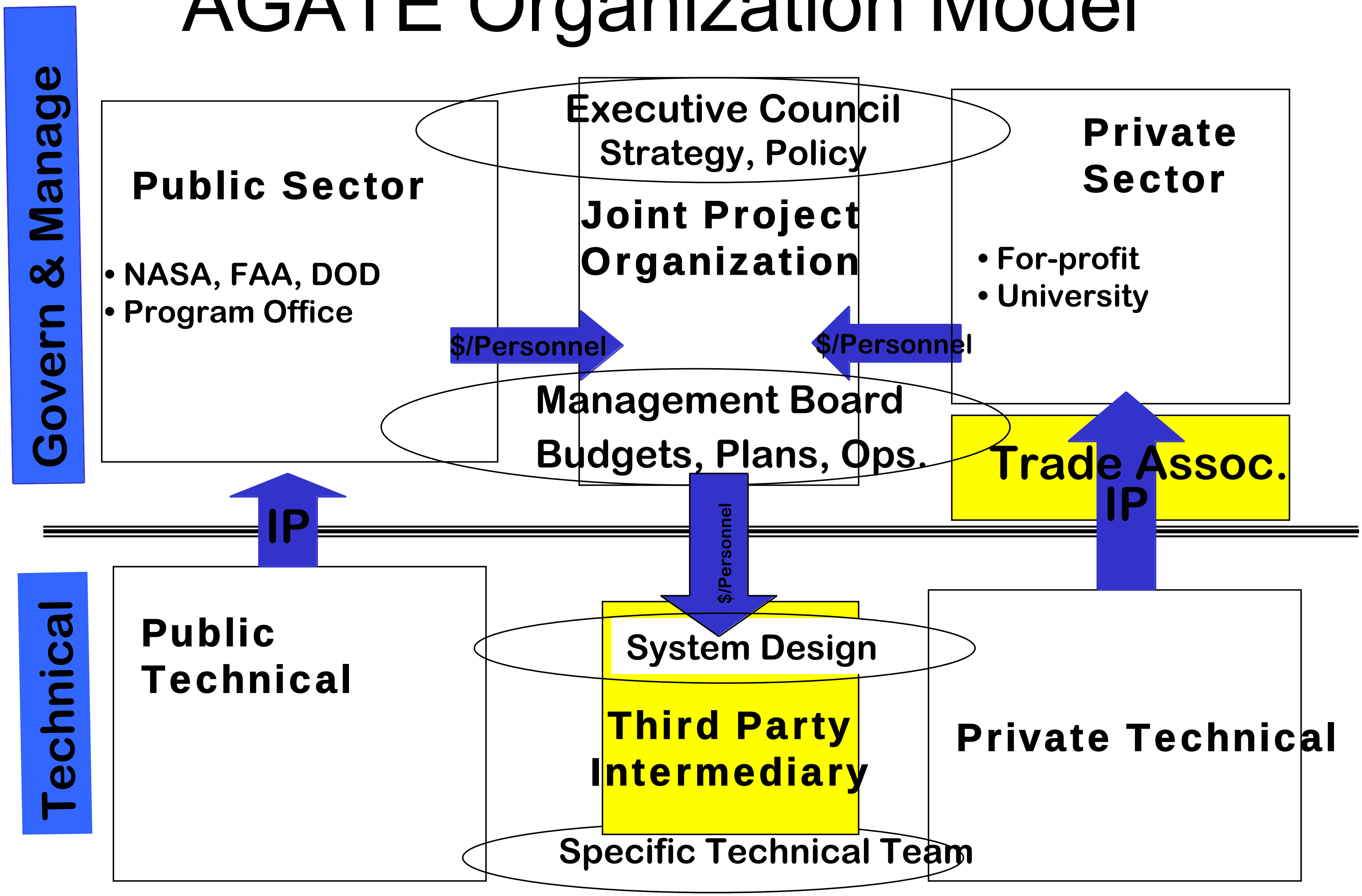
Comparative Analysis

Vertically integrated	Does the partnership consists of a comprehensive range of business categories?
Horizontally integrated	Does the partnership consist of only members from one industry category of deployment,e.g. OEM?
Industry-wide impact	Is the intent of the program to enrich a broad or narrowly focused industry need?
Alternative dispute resolution	Does the Agreement contain language which offers non-litigous options, such as mediation or arbitration?
Up-front Intellectual Property	Are the IP assets baselined and defined a priori to Commingling? Are the subsequent IP rights defined and granted by the Federal partner?

Generic Organization Model



AGATE Organization Model



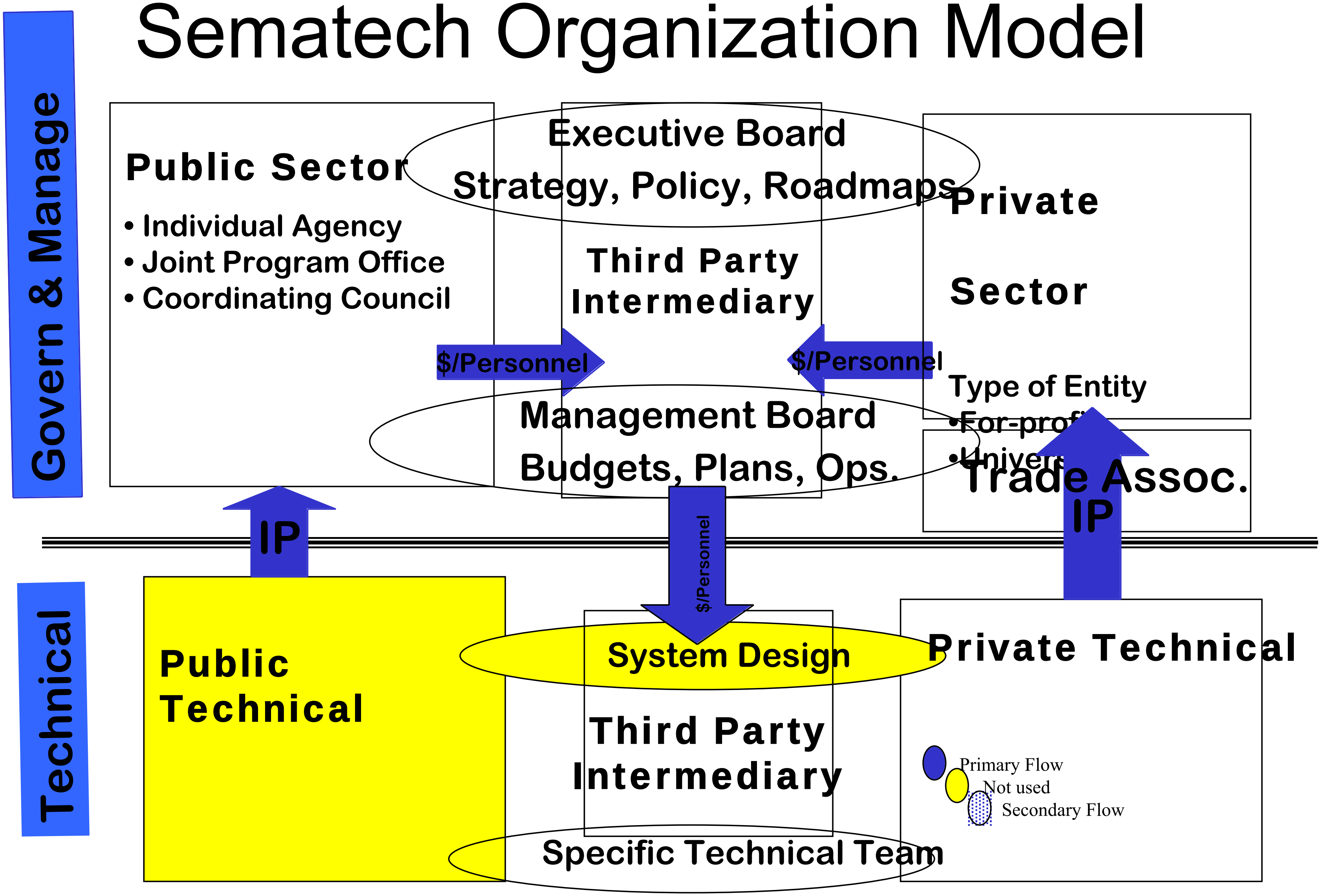
Comparative Analysis
Sematech

Joint planning	Strategic vision and annual planning was joint-inlcuding DARPA. The Roadmap developed really was driven by Private sector.
Joint funding	True 50-50 joint funding. In-kind was not included. Fees based upon firm size.
Co-management	Not truly-Sematech was managed by private interests with some influence by DARPA.
Use of Non-profit, intermediary	Sematech was a stand alone, 501 c (3) third party intermediary.
Systems technology development-	Not really. Initially only focused on chipset design, then included materials and equipment. Never linked complete IT system to program.

Comparative Analysis
Sematech

Vertically integrated	To some degree-and not an initial position of the partnership.
Horizontally integrated	Absolutely. Included almost every member of the chip manufacturer, equipment supplier and materials house at one point or another.
Industry-wide impact	Absolutely. Chip and equipment sales have dramatically improved and Sematech is one of the key contributors. In 1994 the partnership relinquished federal funding.
Alternative dispute resolution	Not known.
Up-front Intellectual Property	Intellectual property was defined by CRADA regulations with the exception of “march-in” rights were dropped from the language.

Sematech Organization Model



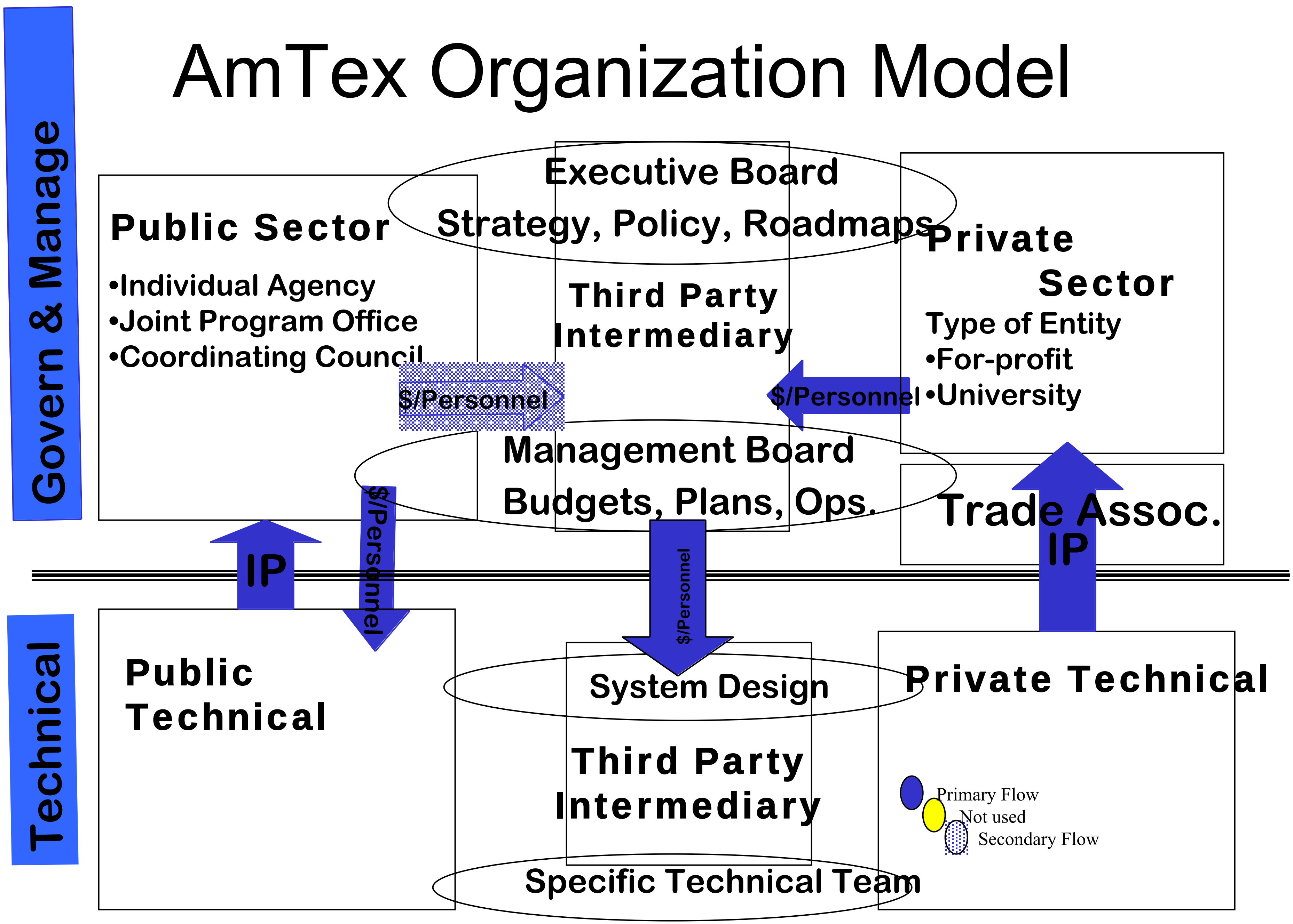
Comparative Analysis
Amtex

Joint planning	Established an Oversight Board (federal policy consensus) and Oversight Committee (joint). A Road Map was established.
Joint funding	50-50% cost share.
Co-management	There were three level of joint management: Industry Technical Advisory, Technical Area Advisors and Project Steering Committee.
Use of Non-profit, intermediary	AMTEX Program Office was established and commingled the planning and execution elements of the project.
Systems technology development-	Not applied.

Comparative Analysis
AmTex

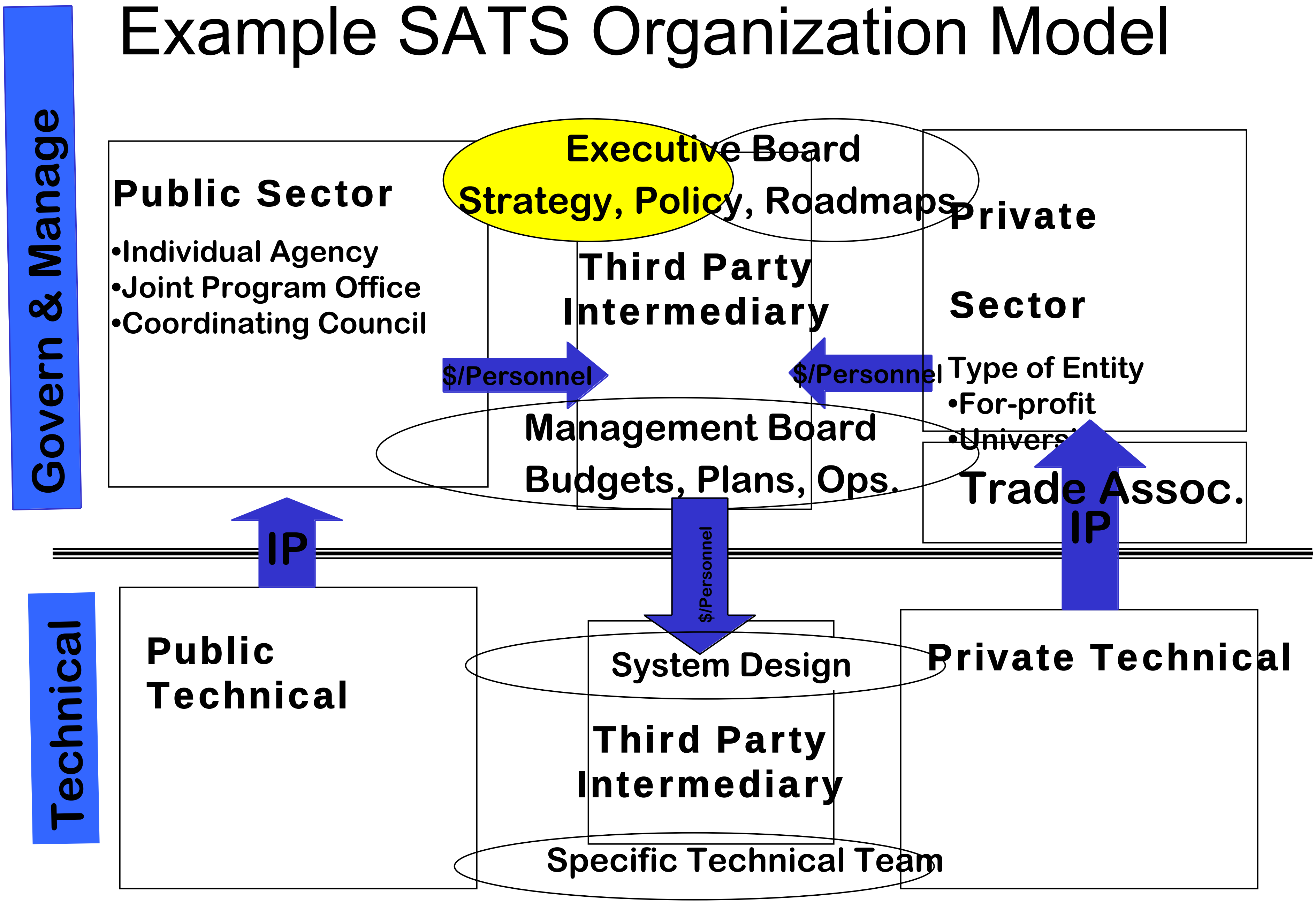
Vertically integrated	Yes, included all the nationals fibers, textiles, fabricated products and retail.
Horizontally integrated	Yes-included multiple entities from each sector.
Industry-wide impact	Yes.
Alternative dispute resolution	Yes. Began with mutual discussion which led to Arbitration.
Up-front Intellectual Property	The Third Party received all rights, title and interests. Each research partner received an exclusive license.

AmTex Organization Model



Backup Slides

Example SATS Organization Model



IMPLICATIONS FOR Workshop Participants

- The role of an active intermediary (I.e. NASA's partner) has been confirmed through precedence.
- Partnerships envisioning significant economic impact use a strong partner.
- The partner characteristics have consistent attributes regardless of industry:
  - Strong executive sponsorship to coalesce industry
  - Key personnel contributed from industry
  - Funding contributed by both sectors commingled for disbursement by partner.
  - Intense joint planning process and and management implementation.

INITIAL FINDINGS

- **Dimensions of a Partnership**

Attributes	Components
Purpose of Partnership	Strategic Motivations
Nature of the Industry	Type, size structure, maturity, Relative US Competitiveness Distribution of funding History of Federal Interaction Politival Factors Industry Associations and other players

INITIAL FINDINGS

- **Dimensions of a Partnership**

Attributes	Components
Goals of Partnership	Types, revolutionary nature Nature of goals Underlying motivation for goals Motivation of participants
Membership and Structure	Types of members Exclusivity of membership Horizontal and vertical linkages of industry Dues Cultural Factors Flexibility of structure.

INITIAL FINDINGS

- **Dimensions of a Partnership**

Attributes	Components
Funding and Legal Vehicles	Total level of funding Level and nature of federal funding Level and nature of private funding
Working Arrangements	Management style and structure. Technical organization Facilities Intellectual Property
Accountability	Requirements, metrics, formal review
Life Cycle	Renewal, term, exit strategy