# NASA Aviation Safety and Security Program

**Briefing to Office of Management and Budget**

**NASA Headquarters**

**June 2, 2004**

**George B. Finelli**

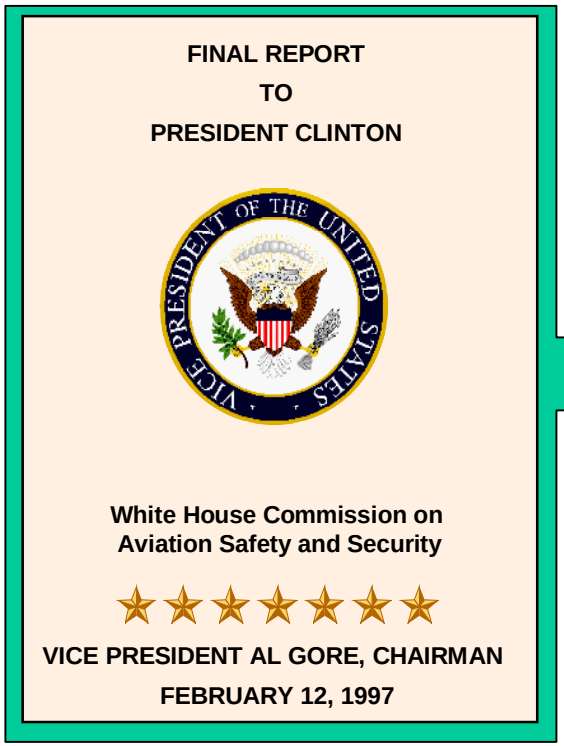
**Manager, Aviation Safety & Security Program**

**NASA Office of Aeronautics**

# Outline

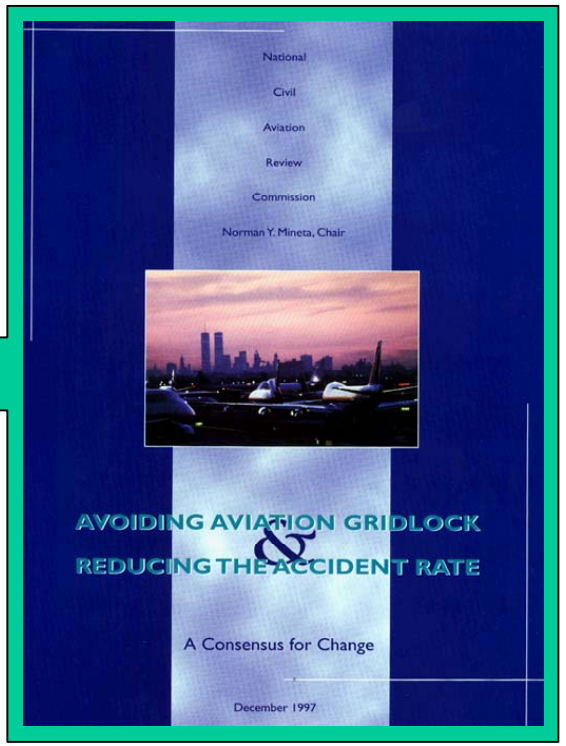
- **Program Overview**
- External Coordination
- Current Safety Projects
- Security Projects
- Future Safety Projects

# Origins of the NASA Aviation Safety Program




**"We will achieve a national goal of reducing the fatal Aircraft accident rate by 80% within 10 years."**

***President William J. Clinton, February 12, 1997***



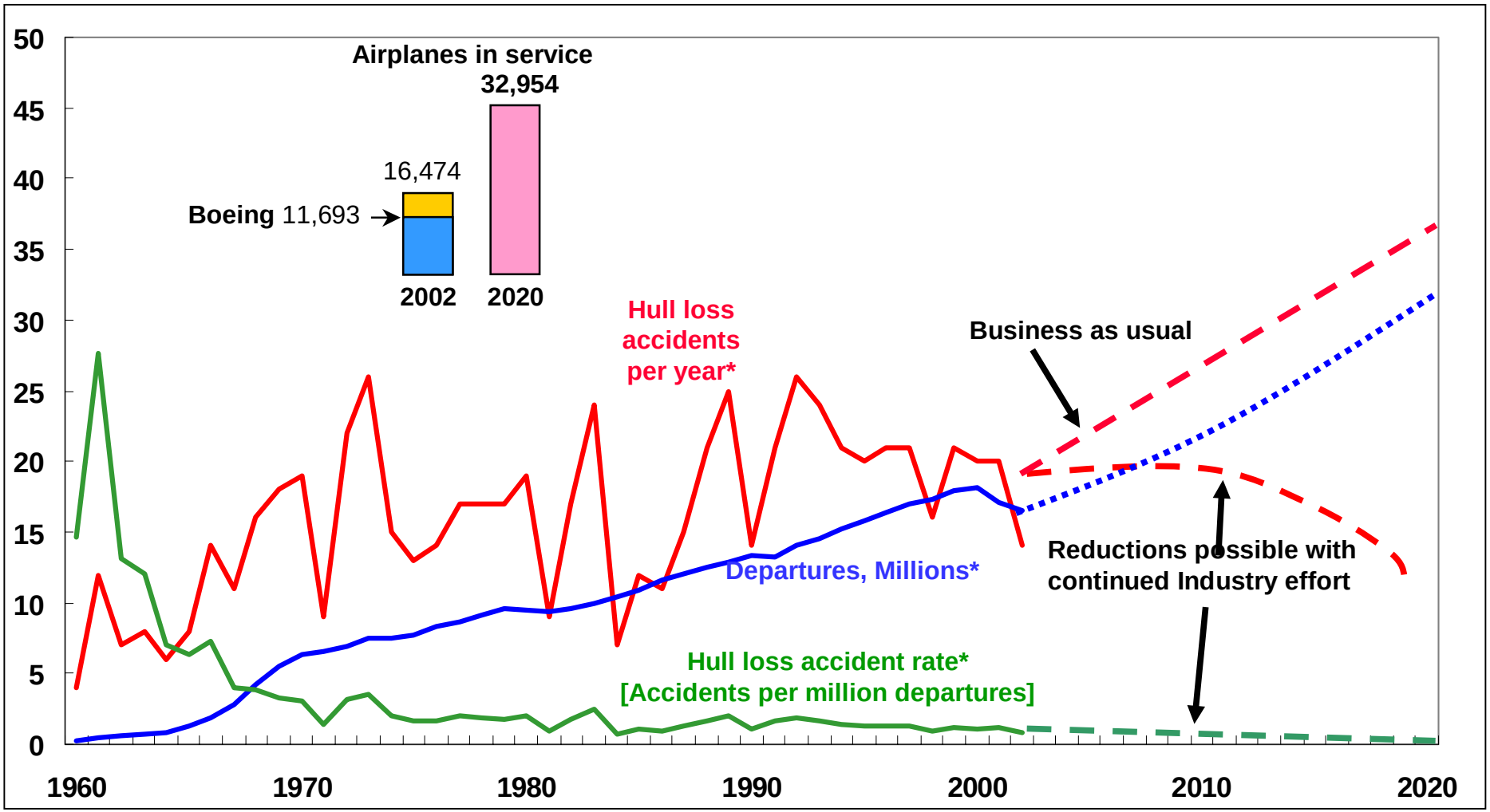

## NASA Aviation Safety Program Goal

**Develop and demonstrate technologies that contribute to a reduction in the aviation fatal accident rate by a factor of 5 by year 2007**

# National Challenge

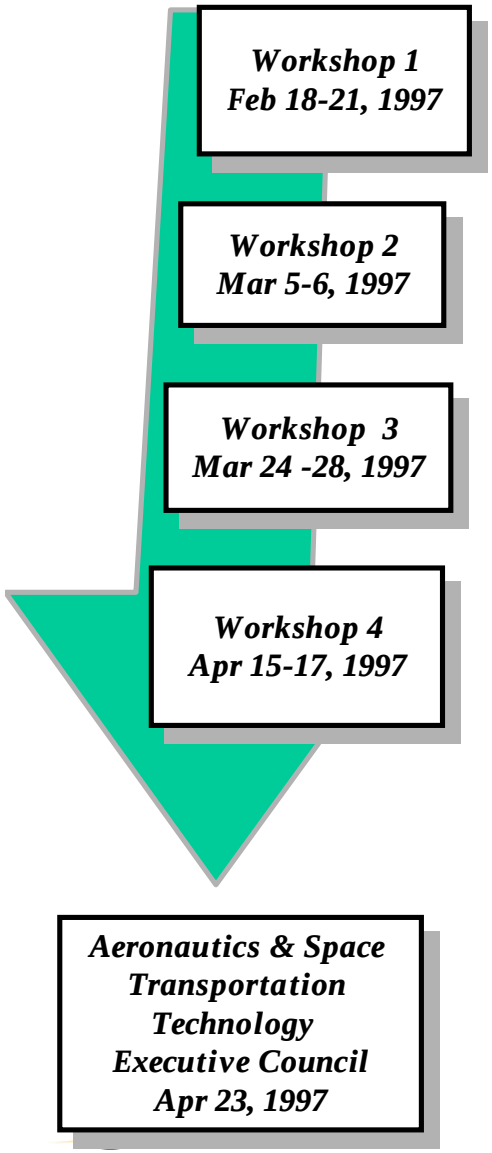


*We Need to Continuously Improve Aviation Safety*

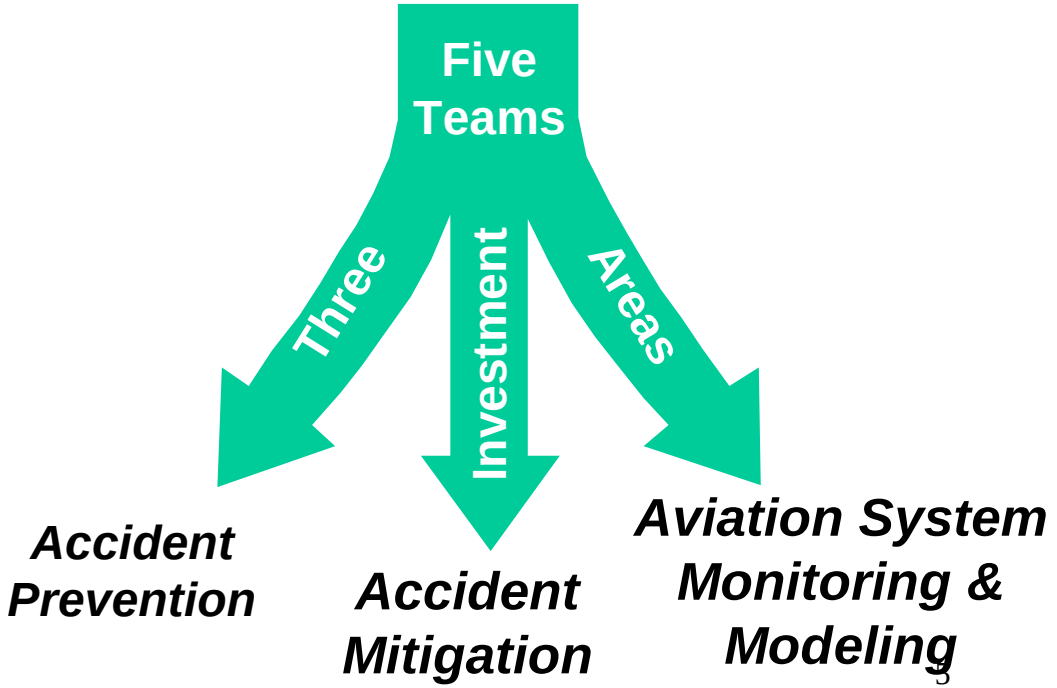



*Accident and Departure data through 31 December 2002

# Aviation Safety Investment Strategy Team (ASIST)




- Over 100 gov't/industry organizations
- Five sub-teams produced 58 prioritized recommended investments
- These 58 were grouped into 23 planning elements in three investment areas



**NASA's Vision**

- To improve life here
- To extend life to there
- To find life beyond

## NASA's Mission

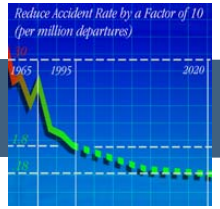
- To understand and protect our home planet
- To explore the universe and search for life
- To inspire the next generation of explorers

…as only NASA can

# Aeronautics Enterprise

***Aeronautics Technology Theme***

## Theme Objectives

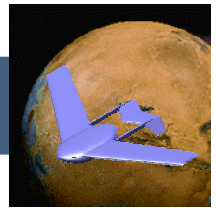



**Protect Air Travelers and the Public**


**Protect the Environment**

**Increase Mobility**

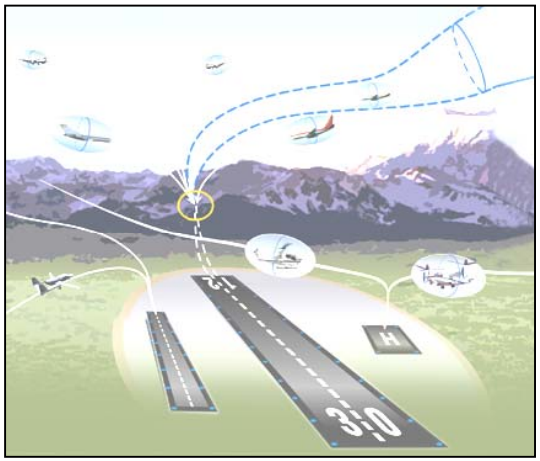
**Protect the Nation**



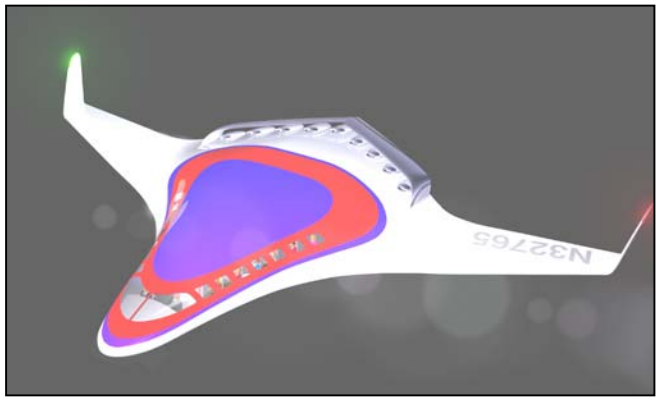
**Explore New Aeronautical Missions**

## Programs

**Aviation Safety & Security**

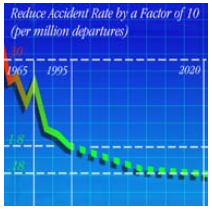


**Airspace Systems**



**Vehicle Systems**

# Comparison of FY 2000 to FY 2003




## FY 2000 NASA Strategic Plan

**Goal: Revolutionize Aviation**: Enable a safe, environmentally friendly expansion of aviation

**Objective: Increase Safety**: Make a safe air transportation system even safer

- Reduce aviation's fatal accident rate by a factor of 5 within 10 years (1997 baseline), and by a factor of 10 within 25 years.

## FY 2003 NASA Strategic Plan

**Goal:** Enable a Safer, more secure, efficient, and environmentally friendly air transportation system.

**Objective: Protect Air Travelers and the Public**

- Decrease the aircraft fatal accident rate and the vulnerability of the air transportation system to threats and mitigate the consequences of accidents and hostile acts.

**AvSSP Safety Goal:** Develop and demonstrate technologies that contribute to a reduction in the fatal accident rate by 50% (minimum success) from the FY 1991--1996 average (target: 80% or factor of 5).

# AvSSP Strategic Plan Outcomes

- By 2005, research, develop and transfer technologies that enable the reduction of the aviation fatal accident rate by 50% from the FY 1991-1996 average.
- By 2009, research, develop and transfer technologies that will reduce the vulnerability exposure of the aircraft and reduce the vulnerabilities of other components in the air transportation system.
- By 2012, facilitate the near real-time identification and resolution of risks and vulnerabilities in the air transportation system.

# AvSSP Strategic Foci

**Human Error Avoidance**

ARC, LaRC

**Protecting Air Travelers and the Public**

**Aircraft Self-Protection & Preservation**

LaRC, GRC

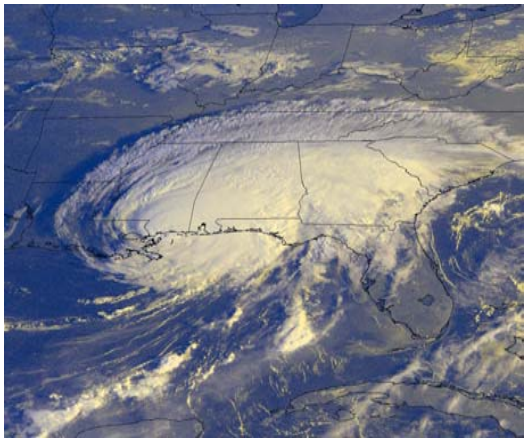
**System Vulnerability Discovery & Management**

ARC, GRC, LaRC, DFRC, JPL

**Hostile Act Intervention & Prevention**

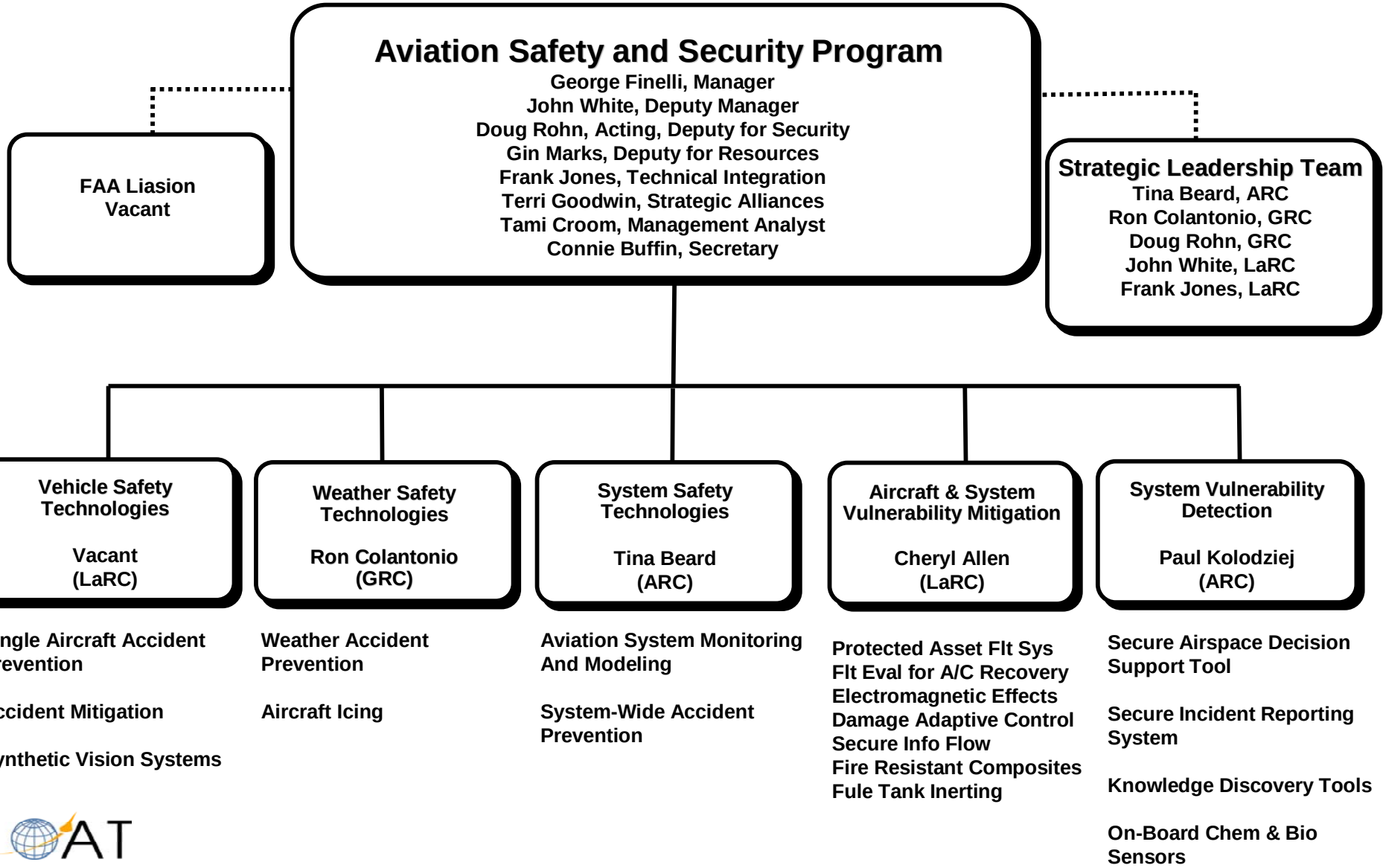

LaRC, GRC, ARC, DFRC

**Environmental Hazards Awareness & Mitigation**



LaRC, GRC, DFRC

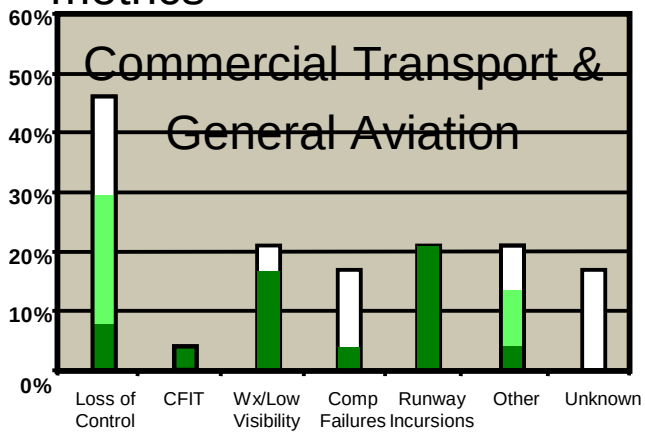
# Organizational Structure



# Progression of R&D

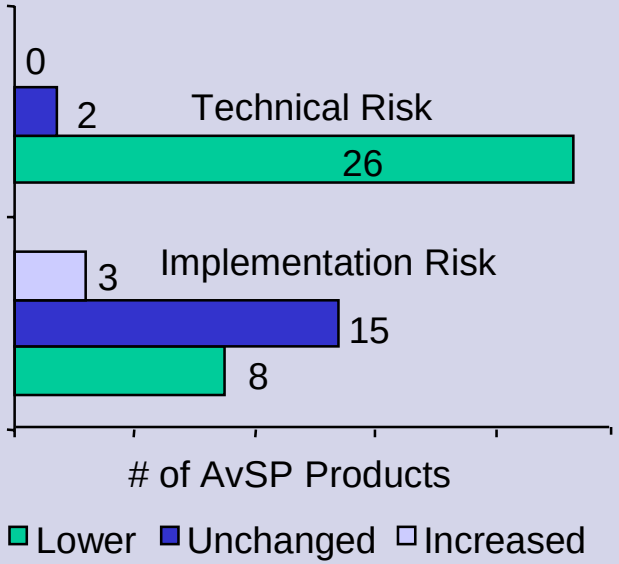
## Portfolio Definition

- Understanding the National needs
- Aircraft, airspace, and airport vulnerability
- Portfolio benefit and prioritization
- Product definition
- Program and product metrics



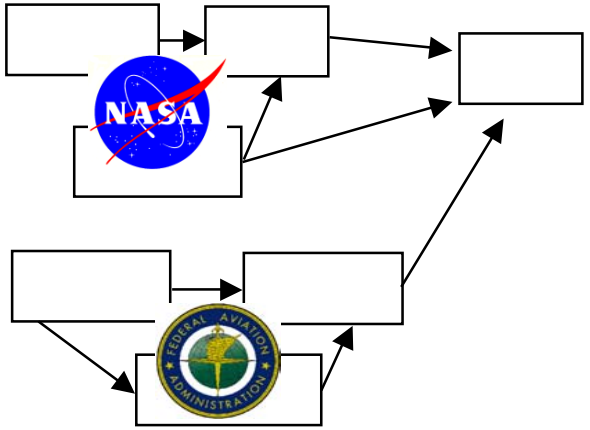

## Technology Development

- Technology development risk
- Implementation strategies and risk
- Cost Benefit
- Technology effectiveness




## Technology Transfer

- Certification guidelines
- Prototype demonstrations
- Benefits validation
- Business case



2000 2001 2002 2003 2004 2005

# Progression of Technology Maturity

**Safety Improvement Concept Designs Developed**

**(9/2001)**

**Simulations & Flight Test Evaluations of Safety Improvement Systems w/in AvSP Complete**

**(9/2003)**

**Integrated Full Mission Applications, Simulations, & Flight Demonstrations**

**(6/2005)**

***Data-based Analysis & Projections***

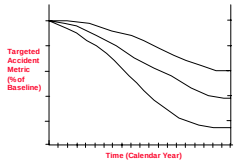
***Mathematical Models***

***Part-Task Simulations***

***Full Mission Simulation***

***Technology/Vehicle-Specific Flight Evaluations***

***Integrated Flight Demos***




***Increasing Knowledge & Fidelity***
***Increasing Technology Readiness Level***
***Increasing "Transfer-ability"***

# Outline

- Program Overview
- **External Coordination**
- Current Safety Projects
- Security Projects
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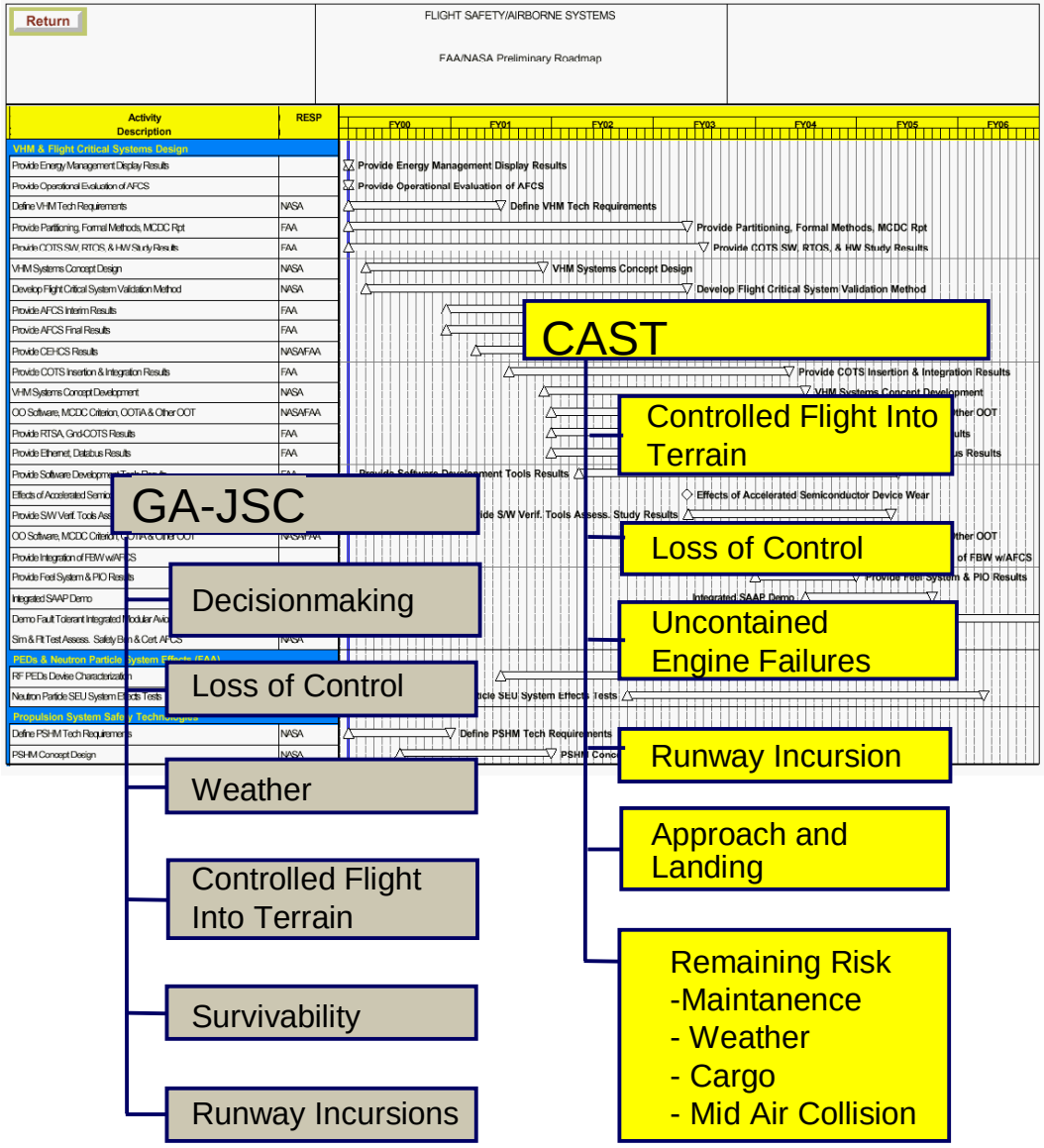
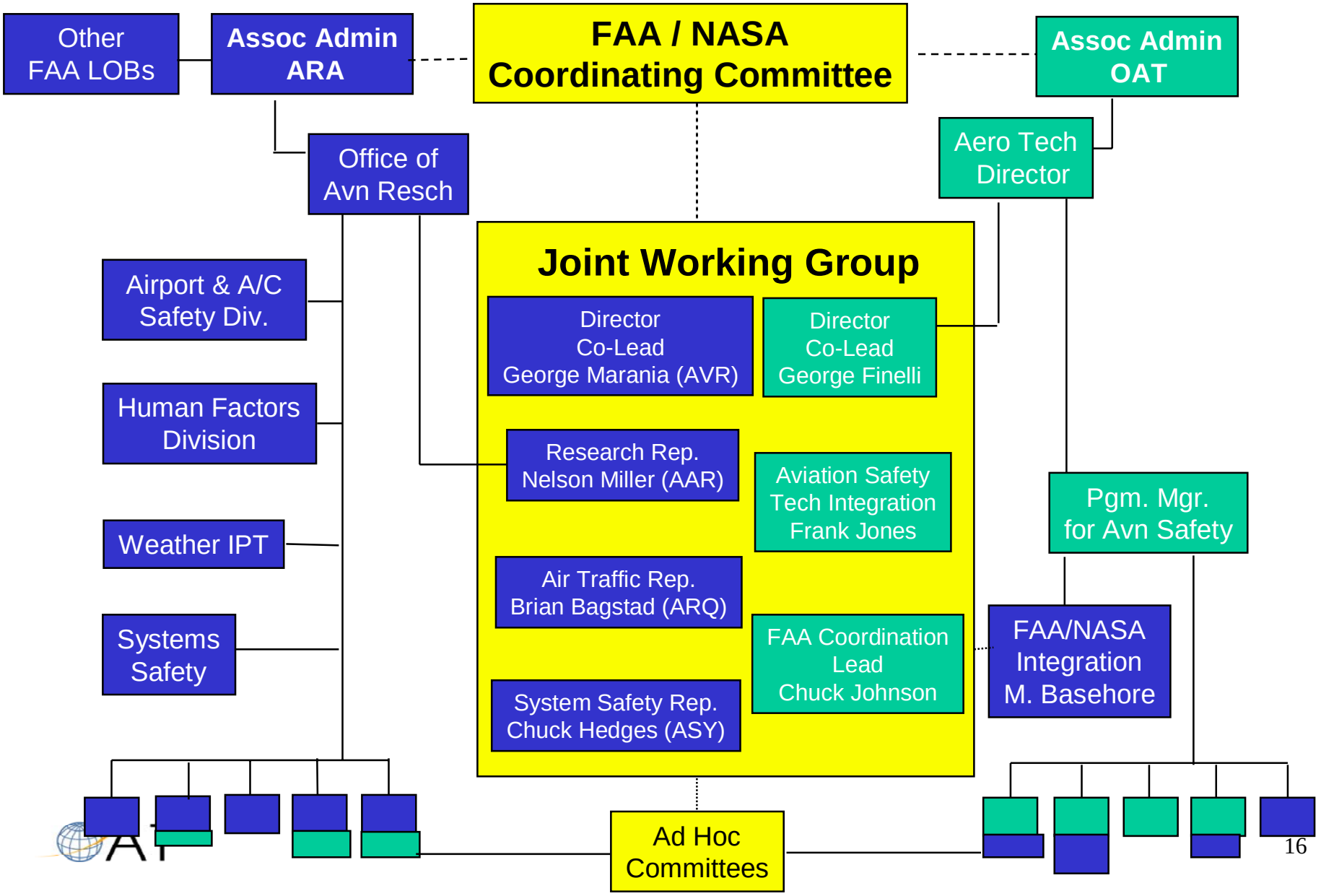
# Product Implementation Strategy

- Program Assessments (technical & implementation risk
- Identify “product” implementation strategies
- Establish business case
- Prototype demonstrations in relevant environment
- Mitigate implementation risks through customer coordination and partnerships
  - NASA/FAA Joint Roadmaps
  - Commercial Aviation Safety Team (CAST) R&D and Safety Enhancement Plans
  - General Aviation Joint Safety Committee (GA-JSC)
  - External Reviews (NRC, ATAC)



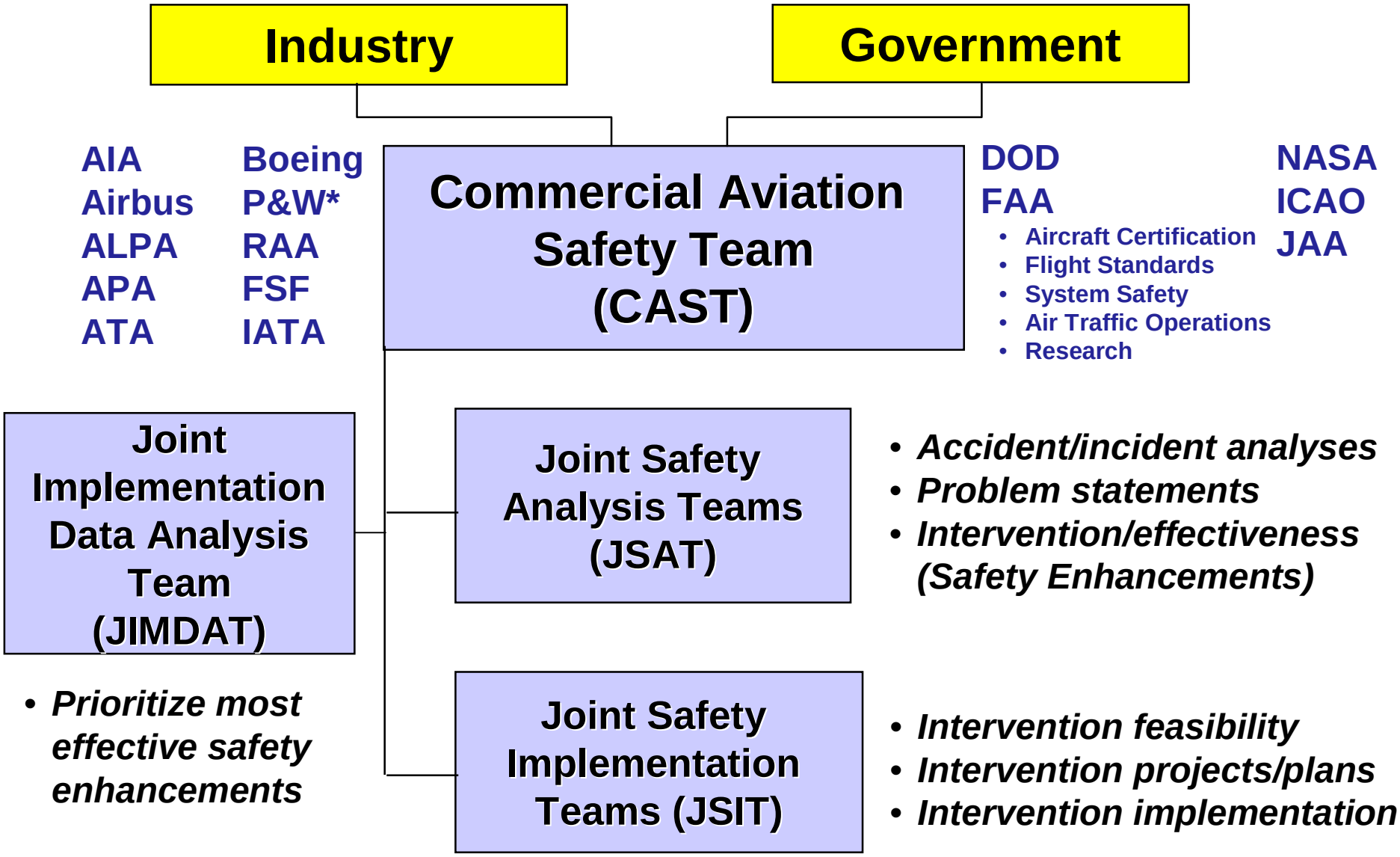
# NASA / FAA Safety Research Partnership



# FAA/NASA Joint Working Group

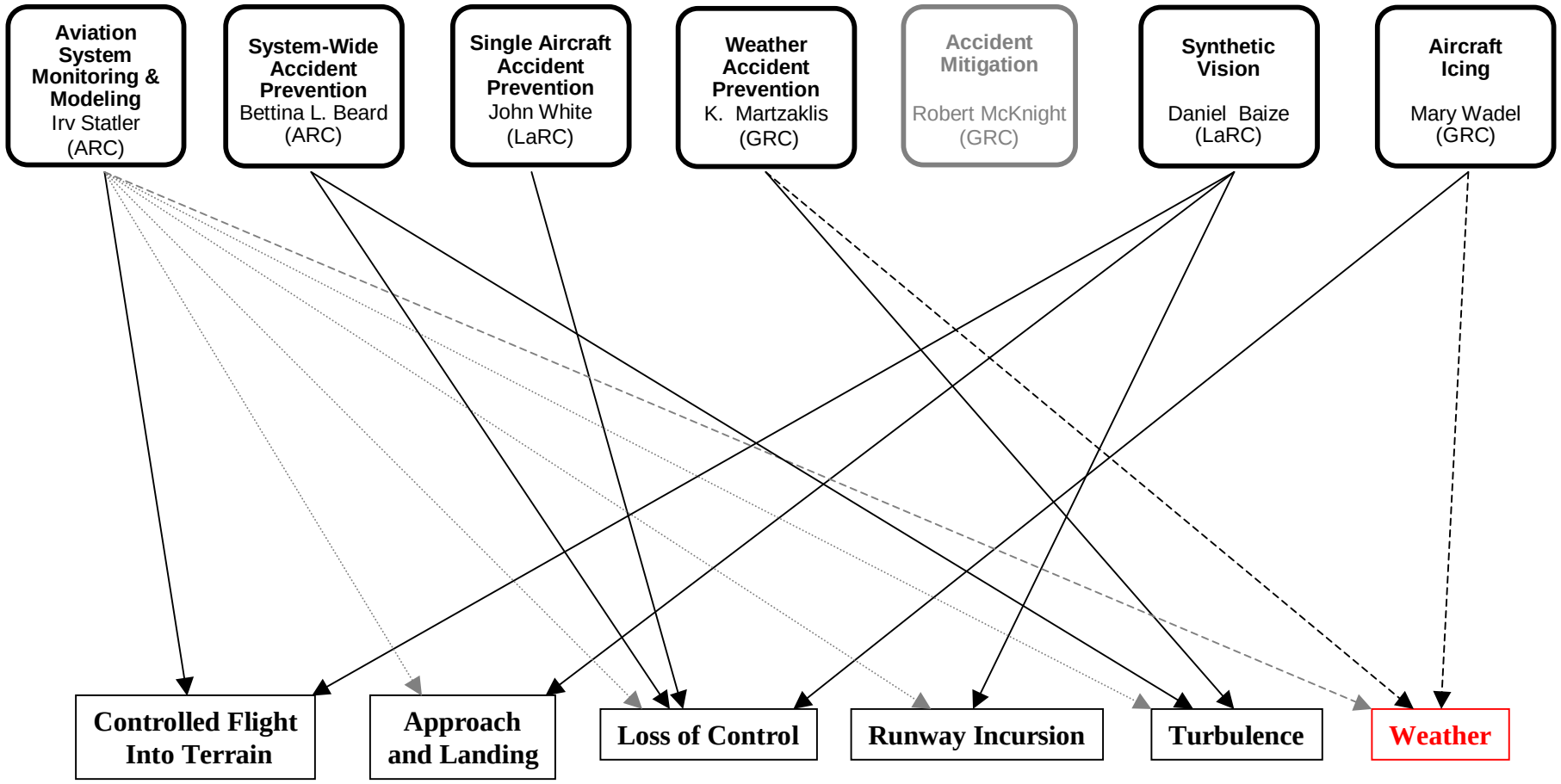

- A yearly evaluation of the level of communication, coordination and collaboration — between FAA and NASA in achieving their shared safety-related research goal
- Based on revised “FAA-NASA Integrated Safety Research Plan (FY2000 Edition),” August 2000

# Commercial Aviation Safety Team (CAST)




*Representing GE and RR

# AvSP & CAST Safety & R&D Enhancements



# CAST R&D Plan

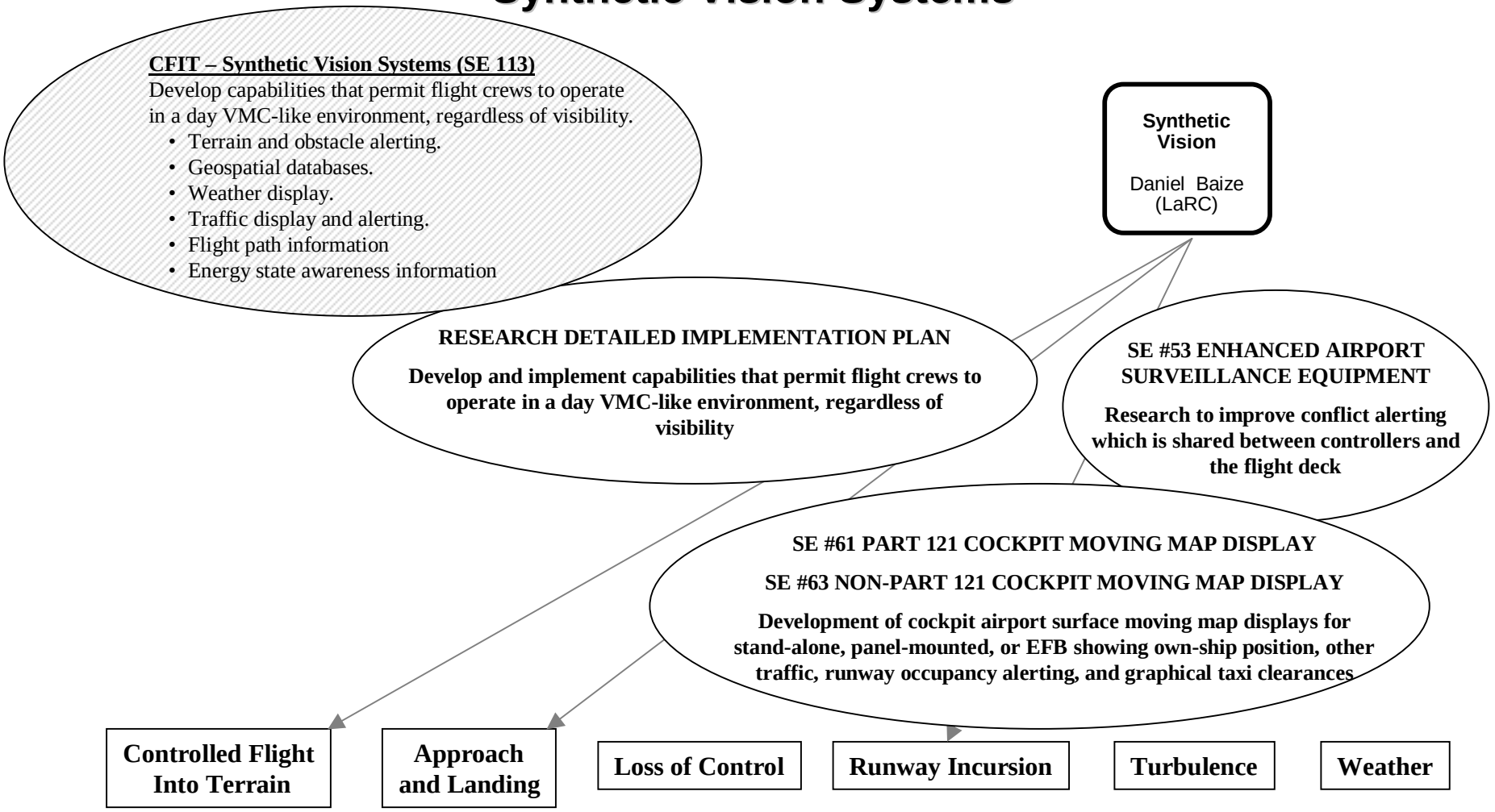
- **CAST recommended 8 R&D actions and 2 studies.**
- **Research community will compare this request to existing/ongoing programs.**
- **Will identify where CAST requests can be met by existing program and where there are gaps between CAST request and current research programs.**

# CAST "R&D" Safety Enhancements

| SE# | Description | JSIT | Lead | Assistant |
|---|---|---|---|---|
| 113 | Synthetic Vision Systems | CFIT | NASA(LaRC)<br>Cheryl Allen | FAA(AND-500)<br>Steve Ritchey |
| 114 | FOQA & ASAP | CFIT | NASA(ARC)<br>Tom Chidester<br>Irv Statler | FAA (ASY)<br>Bob Anoll<br>John Lapointe |
| 118 | Health & Usage Monitoring Systems (HUMS) | ALAR | NASA(LaRC)<br>John White | FAA(AAR-400)<br>Bill Emmerling |
| 119 | Icing Detection, Annunciation, and Mitigation | LOC | NASA(GRC)<br>Mary Wadel<br>Immanuel Barshi - ARC | FAA(AAR-400 & AUA-400)<br>Charlie Masters<br>Gloria Kulesa |

# AvSP & CAST Safety and R&D Enhancements

## Synthetic Vision Systems

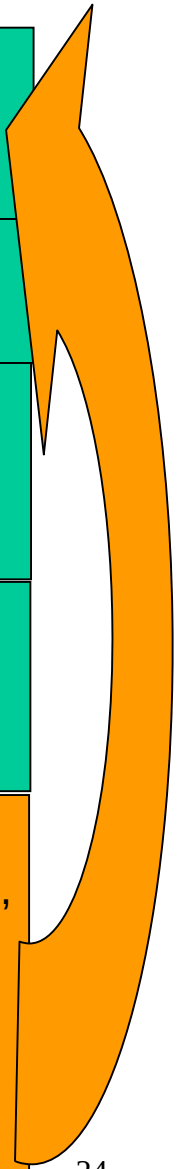


# CAST Request to NASA

- **Assess effectiveness of CAST safety enhancements**
- **Proactive management of future risks**
  - Develop process
  - Collect and analyze data

# Concept of Operation

| | |
|---|---|
| ***Identify*** | – Provide expertise and leadership to develop process and methodologies for identification of existing, changing, and emerging risks |
| ***Evaluate*** | – Data and Analysis Tools (Digital & Text) |
| ***Formulate*** | – CAST develops and maintains Safety Enhancement Plan<br>–Measures and metrics |
| ***Implementation*** | –FAA and Industry<br>–CAST facilitates access to data sources to assess safety enhancement metrics |
| ***Evaluate interventions*** | – NASA Provides tools and expertise<br>–Extract information and reports on performance, safety of the NAS, and CAST Safety Plan effectiveness of enhancements<br>–Conduct analyses of selected measurements and/or metrics<br>– CAST reviews NASA's reports and selects measurements and/metrics for analyses |



# Proactive Management of Future Risks

**NASA has expertise and tools that could provide metric support for safety enhancement effectiveness evaluation.**

- NAOMS, PDARS, APMS
- Issues related to continuation and expansion of NAOMS

**With CAST providing pathway to necessary information, NASA will provide a leadership role in development of processes for identification of changing, emerging, and future risks.**

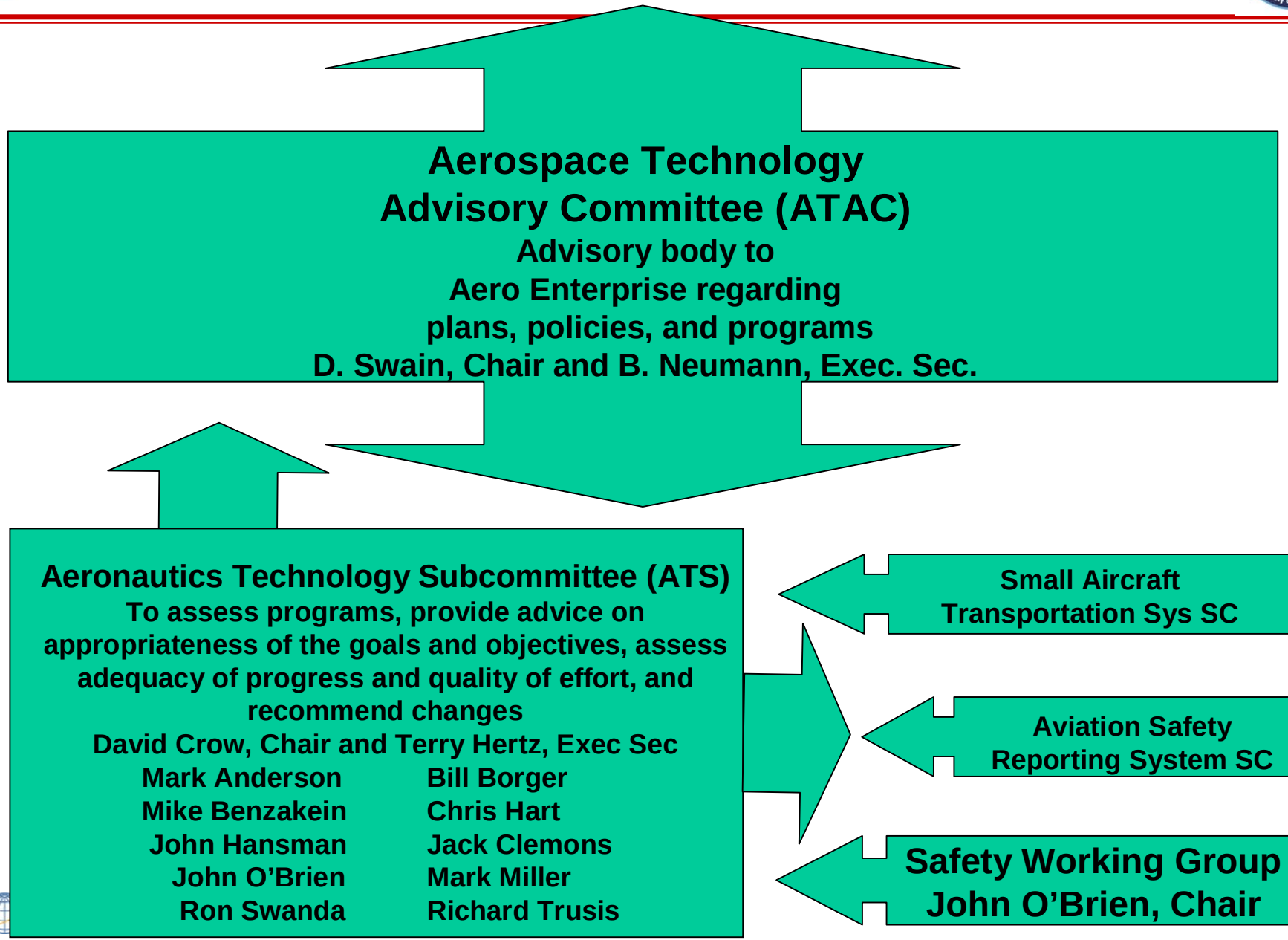
- CAST continue efforts to resolve data acquisition issues
- CAST support/action necessary to ensure adequate resources are available

# Evolving Aviation System

*Anticipate and Prepare for Future Issues*
*as the Aviation System Evolves*

- **NASA actively participating in European-led Future Aviation Safety Team (FAST)**
  - Sponsored by Joint Safety Strategy Initiative under Joint Aviation Authorities
  - A predictive approach that complements retrospective, accident-based methodology of Commercial Aviation Safety Team (CAST)
- **Benefits of a predictive approach to aviation safety--**future may not be a direct extrapolation of the past: *Changes within or external to the aviation system may modify assumptions & introduce new risks.*
- **Current focus area for FAST Ad Hoc study teams:**
  - Increasing use of cockpit automation
  - New concepts for airspace management

# NASA Advisory Council to the Administrator



# Working Group Discussion Items

- NASA should begin/increase its participation in industry/FAA activities:
  - FOQA and ASAP ARC's
  - GAIN
  - CAST Incident Analysis
  - GAJSC
  - JSSI FAST
- Areas to address, focus, refocus:
  - De-identified data/information for aviation system-wide assessment; Analysis tools and analysis of data/information
  - Innovative solutions to future problems through development of future system problem or vulnerability assessment tools
  - Continue PDARS and obstacle & terrain database from STRF, as well as GA incident data through NAOMS
- Proposed restatement of program goal--Develop concepts and technologies to address known safety and security vulnerabilities in the air transportation system and develop a capability to identify future risks and vulnerabilities
- NASA should take a bigger role in developing software certification tools
- General assessment - "Overall a lot of good and powerful work going on."

# Outline

- Program Overview
- External Coordination
- **Current Safety Projects**
- Security Projects
- Future Safety Projects

## Vehicle Safety Technologies

Synthetic Vision Systems

Accident Mitigation

Single Aircraft Accident Prevention

## Weather Safety Technologies

Weather Accident Prevention

Aircraft Icing

## System Safety Technologies

Aviation System Monitoring & Modeling

System-Wide Accident Prevention

# Vehicle Safety Technologies

Objective: Provide Resiliency Against:

- Vehicle System/Component Failures
- Unusual Attitude Loss of Control
- Loss of Situation Awareness due to Low Visibility
- Post Crash & In-Flight Fires

Accident Categories and Causes/Factors:

- Loss of Control
- Controlled Flight Into Terrain (CFIT)
- Runway Incursions
- System/Component Failures

Technology Focus: Aircraft Vehicle Applications

# Weather Safety Technologies

- Objective: Develop and foster the implementation of technologies that will reduce the role of atmospheric conditions (weather, including icing and turbulence) in aviation fatal accidents, incidents, and injuries.
- Accident Categories and Causes/Factors*:
  - Icing and other weather hazards are significant causal or major contributing factors to aviation accidents and incidents.
  - Turbulence is a contributing factor to a large number of aviation incidents involving serious passenger and crew injury.
  - Further, many CFIT and Loss-Of-Control accidents are due to weather-related crew error which could be mitigated by
    - timely, intuitive weather information in the cockpit
    - education and training aids used prior to encountering atmospheric hazards.
- Technology Focus: Weather decision-aiding information, avoidance, and mitigation technologies; icing design and analysis tools; and icing education and training aids for a range of GA, business, and commercial transport applications.

*[*as identified by ASIST, National Aviation Weather Initiative & Plan, CAST]*

# System Safety Technologies

- Objective: A system-wide approach to safe operation and pro-active management of aviation safety risk, enabling a reduction in *frequency* and *severity* of undesired events.
  - Mitigation of safety risk associated with human error and human performance limitations across multiple aviation domains.
  - Development of technologies enabling continuous monitoring and identification of system-wide operational and safety trends, developing conditions, and precursor events/patterns *before* accidents occur.
- Accident Categories and Causes/factors
  - Human error
  - Accident precursors--known and unknown undesirable events
- Technology Focus: To provide reliable predictions of the system-wide effects of changes in technology, procedures, and training *before* they are introduced into the aviation system.
  - Advanced computational models of human performance within aviation contexts, improved training, improved operational and maintenance procedures, and technology product design guidelines.
  - Tools and methods which will provide air carriers, air traffic management personnel, and other air service providers with accurate, insightful, and pro-active measures of the safety, health, and performance of National Aviation System (NAS).

# Program Strategies for Success

***Synthetic Vision Systems***

- **Make every flight the equivalent of clear-day operations**
- **Eliminate runway surface conflicts at all airports**

***Single Aircraft Accident Prevention***

- **Continuously track, diagnose, and restore the health of on-board systems, enabling self-healing designs and "refuse-to-crash aircraft"**

***Accident Mitigation***

- **Increase survivability when accidents do occur**

***Aviation System Monitoring & Modeling***

- **Monitor and assess the safety risk from all data from every flight**

***System-Wide Accident Prevention***

- **Improve human/machine integration in aircraft design and operations**
- **Improve training programs for maintenance operations**

***Weather Accident Prevention***

- **Bring intelligent weather decision making - based on worldwide, real-time hazard awareness - to every cockpit**
- **Eliminate severe turbulence as an aviation hazard**

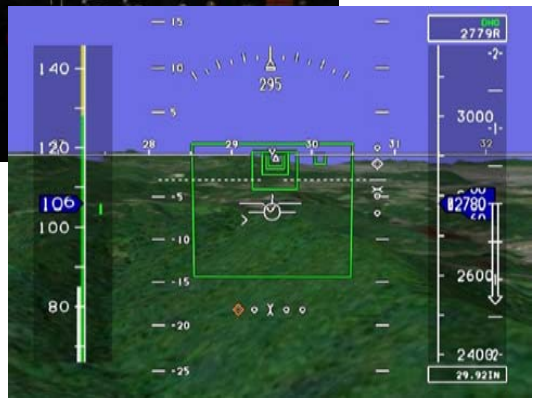
***Aircraft Icing***

- **Eliminate icing safety hazards to all aircraft**

# Program Milestone

## Simulations and Flight Test Evaluations of Safety-Improvement Systems

Wind tunnel testing and analysis lead to advanced simulation capability for improved pilot training to recover from adverse or upset conditions




Terrain Portrayal of Head-Down Display testing in C-206 mitigates loss of control risk by providing additional situation awareness

Honeywell Weather Information Network (WINN) system used in UAL In-Service Evaluation demonstrated time savings and turbulence mitigation

# Program Milestone

## *Simulations and Flight Test Evaluations of Safety-Improvement Systems*

- Complementary simulation and flight test efforts evaluated **critical terrain portrayal concepts** to enable design optimization of SVS applications, as well as developed requirements and recommendations to support certification. Results **demonstrated the efficacy of SVS displays to eliminate Controlled Flight Into Terrain (CFIT) accidents and greatly improve pilot's Situation Awareness (SA).** Prior to the terrain portrayal for head-down displays (TP-HDD) combined experiments, the relationship between the realism of the terrain presentation and the resulting enhancements of pilot SA and performance was largely undefined.

- Developed **graphical weather displays for transport and General Aviation aircraft** and demonstrated in flight using the LaRC 757, ARNAV Cessna 180, and the LaRC B200 King Air. The Honeywell Weather Information Network (WINN) system used in United Air Lines In-Service Evaluations demonstrated time savings and turbulence mitigation. The Rockwell Enhanced Weather Radar system demonstrated the display of uplinked NEXRAD data combined with on-board radar data to provide the pilot with graphical weather information. **Commercialized products for better weather information to flight crews have resulted**.

- F**ast-time simulation**--Using data from NASA developed tools (PDARS, APMS) to validate **simulations and demonstrate the ability to predict the impact of new technologies when introduced into an operating system**.

- Developed **virtual environment of an aircraft cargo bay and artificial defects** such as damaged conduit, corrosion, and cracks for **real-time inspection simulation for improved inspection performance and job training** by the aircraft maintenance industry.

- Developed **cockpit automation training materials** endorsed by the University Aviation Association (UAA) and planned to be used in Purdue University's 4-year curriculum. The UAA endorsement will **facilitate implementation of the products into U.S. training schools.**

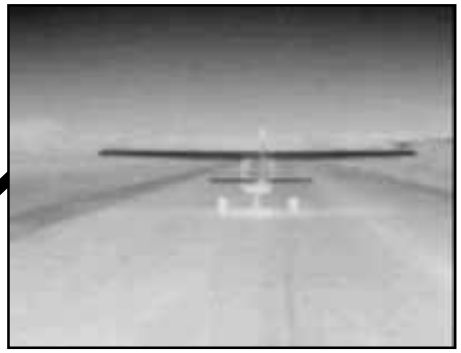
- Completed extensive wind tunnel testing of B757 model, developed **enhancements to database and math models for adverse or upset conditions, and incorporated into vehicle simulation.** As a result, **aircraft flight characteristics that were previously unavailable in upset conditions were obtained** for improved crew training or engineering analysis.

- Documented **"Best Practices in Crash Modeling and Simulation"** as a tool to **assist impact modelers**.

# Synthetic Vision System Components

Accurate Position & Orientation (GPS, ADAHRS)

Worldwide Terrain, Obstacle & Airport Databases



Advanced Sensors for Database Integrity and/or Object Detection (May be too costly for GA)


Real-time Synthetic Vision Display w/ Advanced Guidance

Real-time tactical hazards (FIS-B, NOTAMS)

Relevant Traffic Information (ADS-B, TIS-B)

***Assumed elements of SVS for GA applications: low-cost CPUs, displays, databases, and datalinks are possible.***

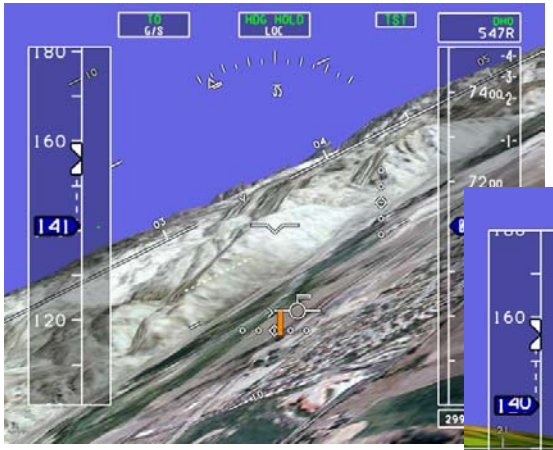
# SVS Eagle/Vail Flight Test Summary

**Objective: Evaluate Safety and Performance Benefits of SVS Display Concepts For Terrain-Challenged Airport Operations**

- **3-week deployment with ARIES**
- **7 evaluation pilots**
- **51.6 research flight hours flown**
- **NASA & Rockwell Collins systems tested**
- **104 Approach and Departure Runs (87 NASA, 17 RC)**

# Experimental Display Concepts & Results

***Photo-Realistic***



***Generic***

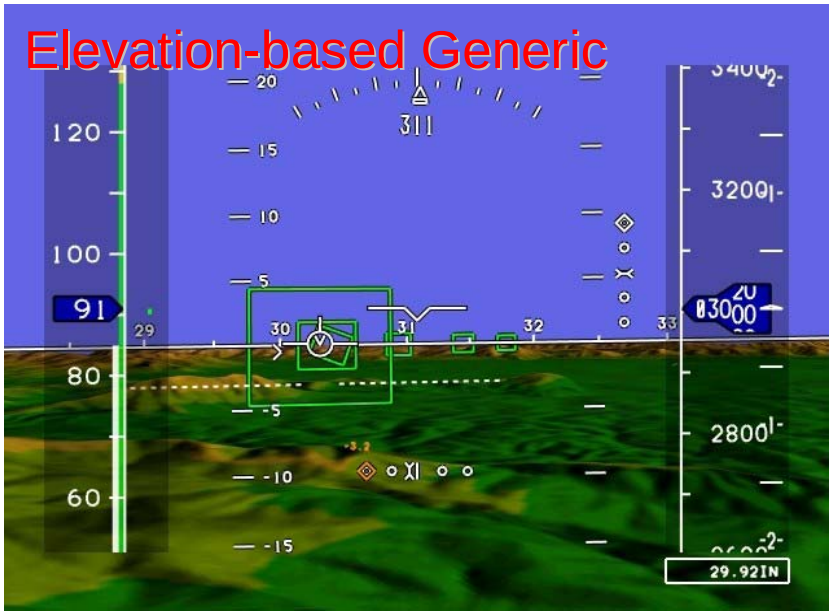
***Stroke-on-Raster HUD***

- **Terrain Depiction**
  - **Generic**
  - **Photo-Texturing**
- **Display Device:**
  - **Head-Down Display (Size & Field-of-view)**
    - ***Unquestioned Terrain Awareness Benefit***
  - **Head-Up Display**
    - ***Terrain Awareness Benefit Shown***
    - ***Issues Identified:***
      - ***HUD Brightness***
      - ***Terrain Texturing***

# SVS-GA Simulation & Flight Test Conclusions

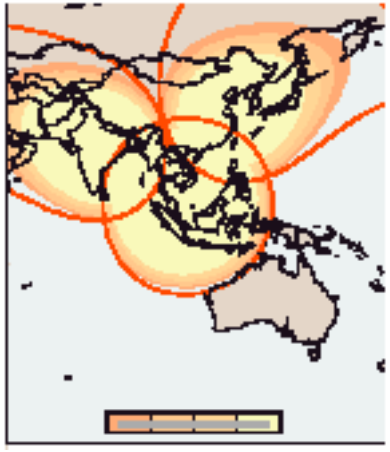
Terrain Portrayal--Head-Down Display

- SVS mitigates loss of control risk by providing additional situation awareness
  - More tests planned to confirm this result
- All SVS concepts increased situation awareness
  - Reduced chance of CFIT by 90%
- All SVS concepts rated significantly better than baseline round dials (current technology) or conventional Primary Flight Display (PFD)
- Photo-realistic not significantly better than Generic (although liked better by pilots)




# Intelligent Weather Decision Making

Honeywell Weather Information Network (WINN) system used in UAL In-Service Evaluation demonstrated time savings and turbulence mitigation



In-service Evaluations of Satellite Weather Information System technologies by AA on pacific rim routes demonstrated excellent SATCOM link performance at low elevation angles


Rockwell Enhanced Weather Radar (EWxR) system demonstrated the display of uplinked NEXRAD data combined with on-board radar data to provide the pilot with graphical weather information

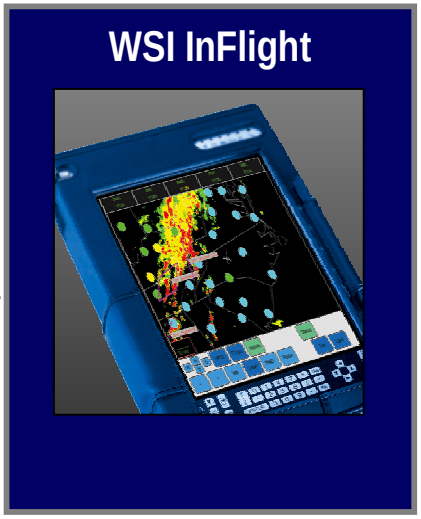
ARNAV Weather Hazard Information system demonstrated the display of weather products in a GA cockpit

Evaluated the impact of graphic weather information on pilot decision making with the Honeywell GA tethered weather information display:

- pilot confidence same as “out the window”
- data time delay not always understood
- contributed to RTCA FIS-B MASPS

# Weather Information Systems
## Examples of Commercialization

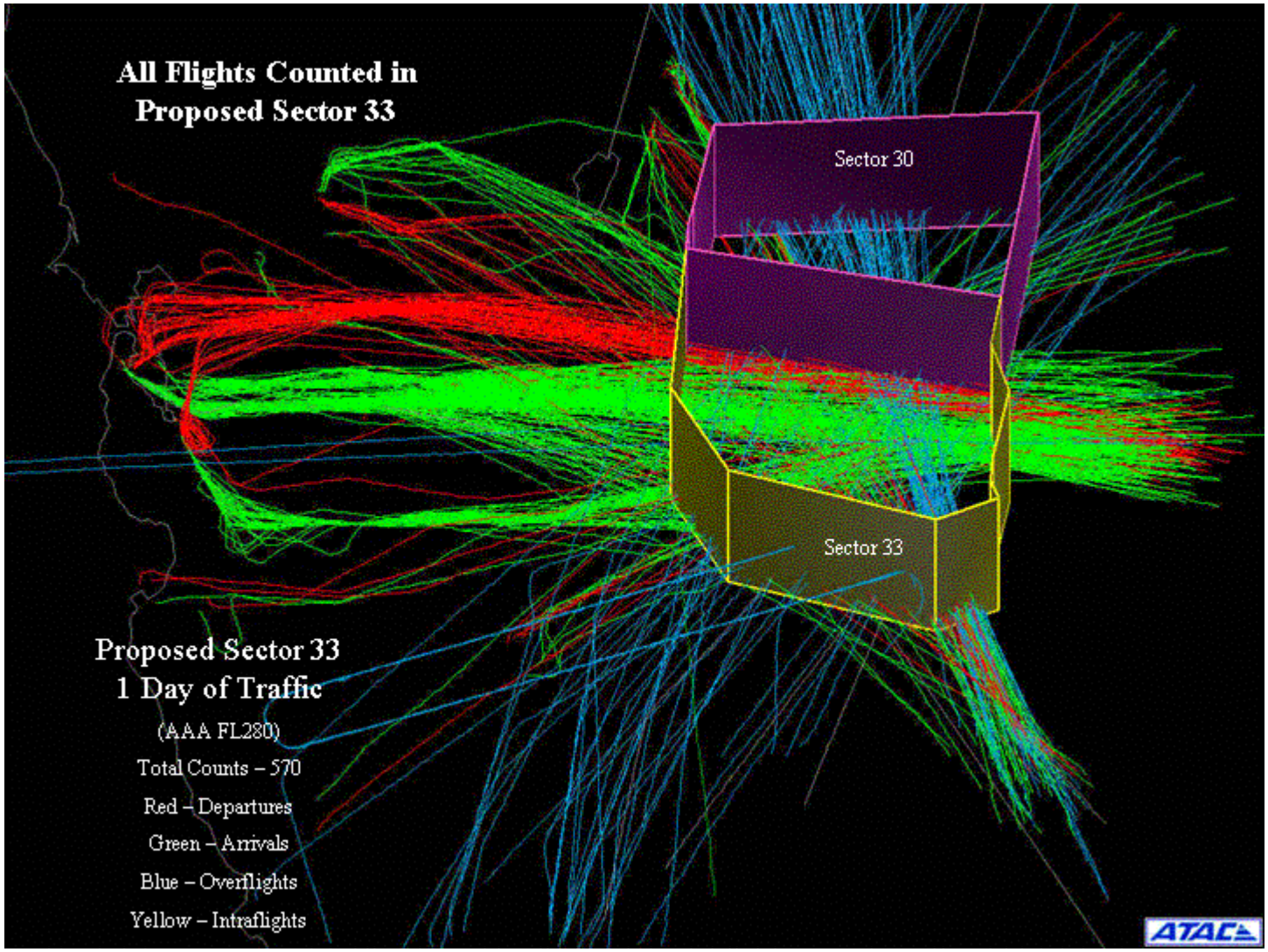
ViGYAN Small Business Innovative Research:




Cooperative Research with ARNAV and Honeywell/Bendix-King:

# PDARS Installation Overview

# Optimization of Airspace



# Current PDARS Uses for Safety

- Optimization of Airspace
  - Splitting a High Volume Sector into Two
- Quality Control of Airspace Definitions
  - Detecting Gaps/Overlaps in new Sector Designs
- Analysis of Class B Airspace
- Analysis of Airspace/Procedural Changes
  - Determine viability of Special Use Airspace/Letters of Agreement
- Enhancement of Training
  - Development of Training Scenarios
- Analysis of Temporary Flight Restrictions
  - TFR Visualization after Columbia accident
- Analysis of VFR/IFR flow interaction
  - VFR Corridor Investigation
- Analysis of TCAS Resolution Advisories

# Awards for Technical Achievement

**Celebrating Outstanding Contributions Towards NASA's Aerospace Technology Enterprise's Goals and Objectives**

**2002**
**Aviation Weather Information & Communications Research Team**


**2003**
**Terrain Portrayal for Head-Down Displays Simulation & Flight Test Team**

**2003**
**Aviation Safety Turbulence Prediction and Warning System Team**

**2003**
**Performance Data Analysis & Reporting System Team**

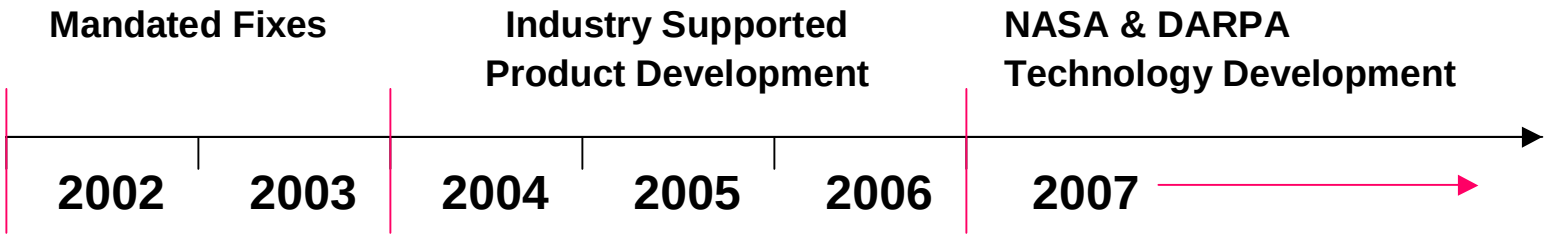
# Outline

- Program Overview
- External Coordination
- Current Safety Projects
- **Security Projects**
- Future Safety Projects

# Why is NASA in Aviation Security?

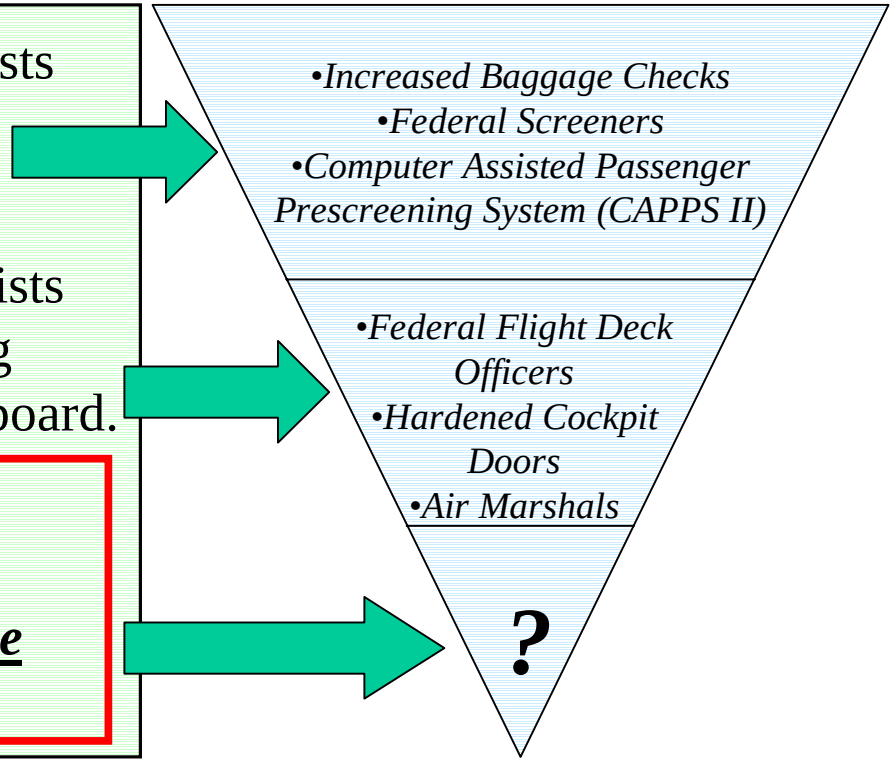
NASA Contributes to National Strategy for Commercial Aviation Security

- Critical role in exploring and producing advanced aviation and space technologies
  - Long history of delivering breakthrough technologies that have enabled the U.S. to lead the aerospace world
  - Uniquely works on technologies beyond the risk level and return-on-investment timeframe of U.S. aviation industry
- Uniquely able to work on technologies and issues with a long-term, system-wide perspective
  - World-class unique researchers, laboratories, simulation and flight test capabilities
  - Capabilities provide the U.S. an alternate source of security technology and enable increased innovation through competition
- Technologies can address security voids in DHS/TSA and DoD programs



# Focus on Mitigation

- …Our first priority is to prevent terrorists from boarding commercial aircraft or getting any type of weapon onboard.
- The second priority is to prevent terrorists from overpowering the crew and taking control of the aircraft if they do get onboard.
- Only if the other interventions are unsuccessful will we need to ***deal with preventing hijackers from crashing the aircraft***.



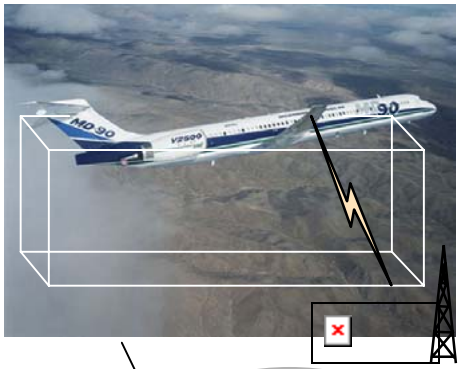

THE NASA AERONAUTICS BLUEPRINT

…terrorists will continue to consider attacks against commercial aircraft in the United States and abroad likely, intending to employ suicide hijackings and bombings as the most promising methods to destroy aircraft in flight, as well as to strike ground targets.

Mr. Stephen McHale, Deputy Administrator, TSA, 5 Nov 2003

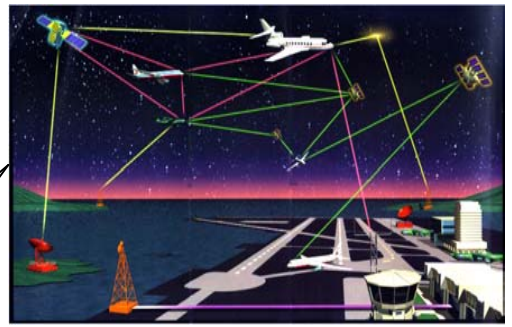
# NASA Approach

*Enable layers of security to minimize vulnerability of aviation to threats*

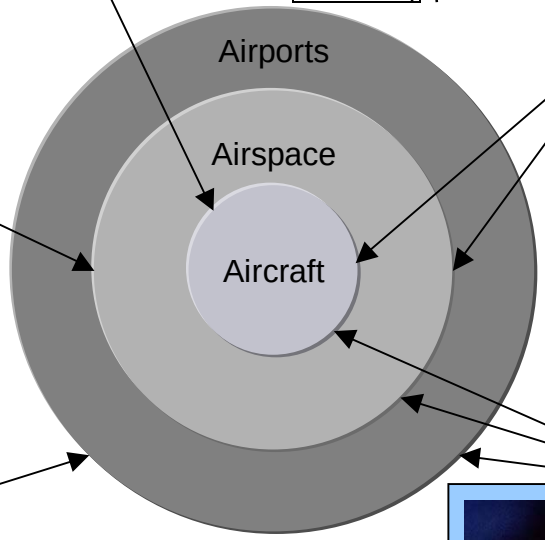


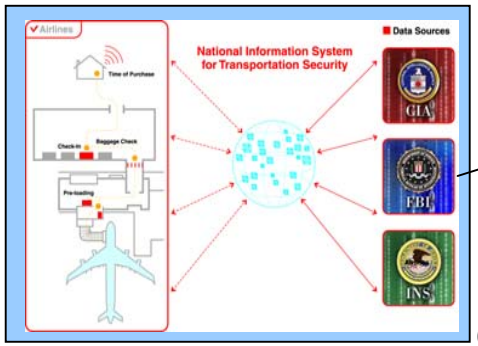
**Secure and protect the aircraft**

**Harden the National Airspace System**

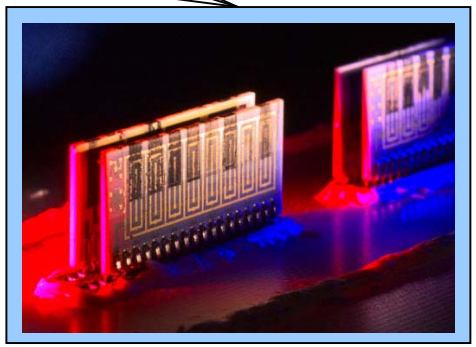


**Secure vehicle CNS systems**




**Increase effectiveness of aviation information screening**

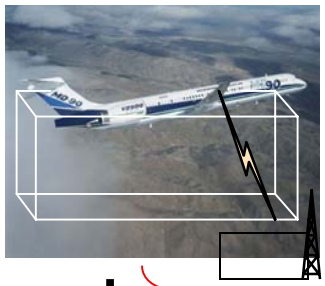


**Integrate advanced sensors into the aircraft**

# Security Projects

**Five Technical Areas**

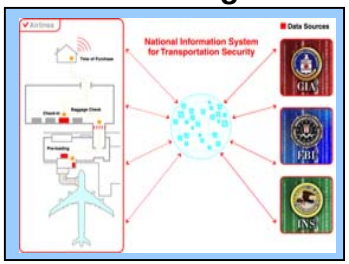
**Secure and protect the aircraft**



**Secure vehicle CNS systems**

**Harden the National Airspace System**

**Increase effectiveness of aviation information screening**




**Integrate advanced sensors**

Primarily a vehicle focus

Airspace system / airport focus

Aircraft application, but detection focus

*Translate 5 areas into WBS Foci & Projects*

**Program Foci / Project**

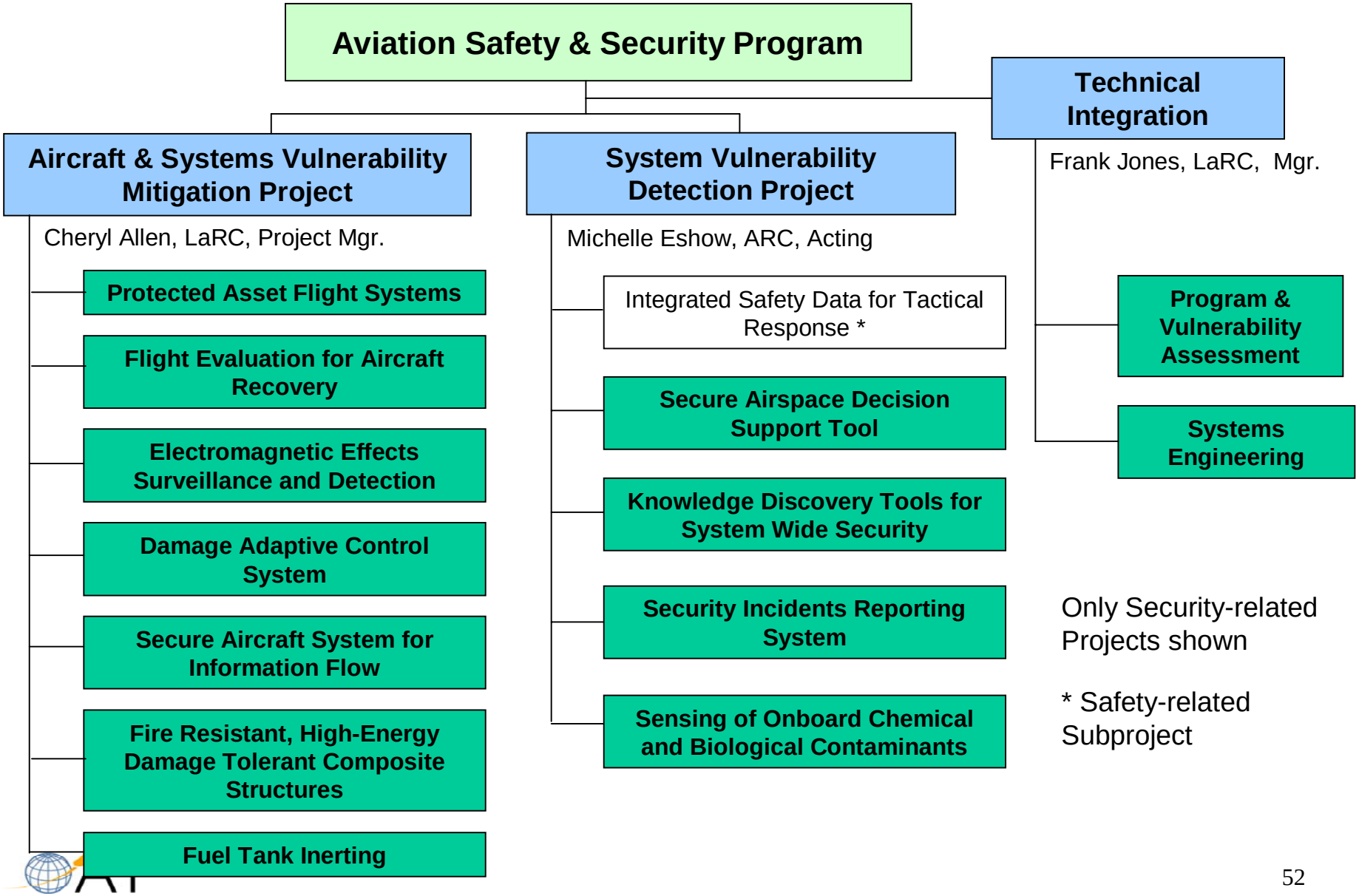
*Hostile Act Intervention & Prevention*

**Aircraft & Systems Vulnerability Mitigation**

*System Vulnerability Discovery & Management*

**System Vulnerability Detection**

# Organizational Structure




Only Security-related Projects shown

* Safety-related Subproject

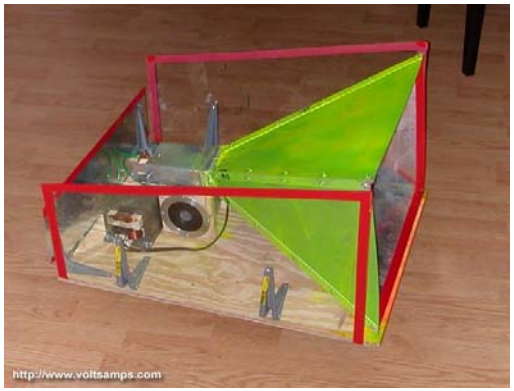
# Objectives

| | |
|---|---|
| **Aircraft & Systems Vulnerability Mitigation (A&SVM) Project** | **OBJECTIVE**: Develop and advance technologies that will mitigate consequences to the aircraft from an intentional attack. |
| **System Vulnerability Detection (SVD) Project** | **OBJECTIVE**: Leverage and advance technologies which will detect and inform users of potential security vulnerabilities in the Air Transportation System. |
| **Technology Integration** | **OBJECTIVE**: (Safety & Security) Identify National Air Transportation System safety and security vulnerabilities. Develop Program prioritization approach and criteria and assess the performance of the research areas against the program goals and objectives. TI will also develop approaches and methodologies to accelerate system implementation onto all users and vehicle classes. |

# Aircraft & System Vulnerability Mitigation

"A More Secure Vehicle Environment in a Newly Hostile World"

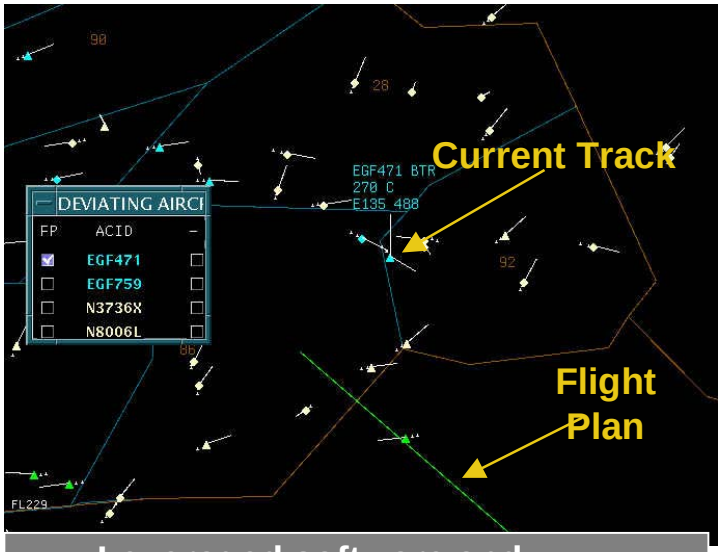
- **Flight systems to deny use of aircraft as weapon or protected area intrusion**
- **Controls systems to mitigate effects of damage from shoulder-launched missiles**
- **Protection against electromagnetic Intrusions**
- **Fuel systems & structure concepts to harden against fire & explosion**




# Aircraft & System Vulnerability Mitigation - II

***Secure aircraft networks and communication links from intentional threats, enable surveillance of aircraft, and minimize protected airspace intrusions.***

# System Vulnerability Detection

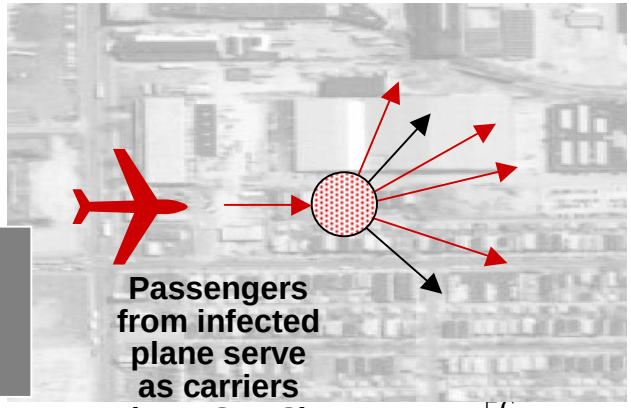



- Leveraged software and infrastructure for ATM decision support tools to increase the effectiveness and reduce the workload of detecting rogue aircraft

- Leveraged IT technologies for real-time multi-database integration and fast, accurate data mining tools to find patterns and anomalies in: Cargo and air traffic screening

- Develop the ability to provide a national confidential Security Incident Reporting System that will serve as a data resource and early warning system for security stakeholders.
- CHALLENGES:
  - Assure confidentiality
  - Resolve legal issues re: protection and/or release
  - Establish limited immunity or other incentive

- Leveraged sensor technology to on-board systems for detection and identification of release of chemical and biological agents



# Coordination with Relevant Government Agencies

**Agency, Office or Activity, Relevance to Program, and Status of Relationship**

- **TSA**/Transportation Security Laboratory
  - RELEVANCE: Current research arm for transportation security technologies
  - STATUS: Regular & direct participation in several technical working groups (TWGs)
- **TSA**/Transportation Security Policy & Security Technologies
  - RELEVANCE: Connection to policy & requirements-setting organizations
  - STATUS: Interactions at Program & HQ (Code R & Code IA) levels; MOU in-process
- **TSA**/Strategic Management & Analysis
  - RELEVANCE: Coordination of vulnerability & risk analysis tools & results
  - STATUS: Developing partnership
- **DHS**/Science & Technology
  - RELEVANCE: Future research arm for homeland security technologies
  - STATUS: Need to further develop
- **DoD**/Joint Aircraft Survivability Program Office (JASPO)
  - RELEVANCE: Aircraft survivability enhancements
  - STATUS: Regular & direct participation by JASPO & Service personnel in TWGs
- **FAA**/Aircraft Airworthiness; Air Traffic; Safety R&D Program
  - RELEVANCE: Ensure developed technologies address implementation concerns
    - Also, some NASA activities apply to FAA-responsibilities (communications, ATM, etc.)
  - STATUS: Continue in strong partnership mode from Aviation Safety Program and Airspace Systems Program

# A&SVM Project

**Aircraft & Systems Vulnerability Mitigation (A&SVM) Project**

- Protected Asset Flight Systems
- Flight Evaluation for Aircraft Recovery
- Electromagnetic Energy Surveillance and Detection
- Damage Adaptive Control System
- Secure Aircraft System for Information Flow
- Database of Lightweight, Fire/Explosive Resistant New Materials
- Fuel Tank Inerting

**OBJECTIVE**: Develop and advance technologies that will mitigate consequences to the aircraft from an intentional attack.

**PRODUCTS (passive barriers and active interdiction)**:

Technologies & methods to provide accurate information to enable pilot avoidance of protected airspace, maintain positive identity verification, and deny flight control access to unauthorized persons.

Flight system technologies for capability to recover a seized aircraft safely to landing.

On-board and ground surveillance & interception system for aircraft immunity to electromagnetic interference (EMI) & electromagnetic pulse (EMP) intrusions.

Flight control system that accommodates damaged control surfaces and changes to aircraft stability and control characteristics; with consideration for FAA certifiability.

Technologies to enable secure communication, navigation, and surveillance (CNS) on-board the aircraft.

Material systems and integrated aircraft fuselage structural concepts that are resistant to fire and explosions.

Fuel systems that are resistant to fire and small arms projectiles.

# SVD Project

**System Vulnerability Detection (SVD) Project**

- Secure Airspace Decision Support Tool
- Security Incidents Reporting System
- Knowledge Discovery Tools for System Wide Security
- Sensing of Onboard Chemical and Biological Contaminants

**OBJECTIVE**: Leverage and advance technologies which will detect and inform users of potential security vulnerabilities in the Air Transportation System.

**PRODUCTS**:

Capability which enhances the security of airspace operations by providing ground controllers an automated capability to identify an errant aircraft, and establish an architecture to coordinate situational awareness between appropriate aviation security authorities in the management of securing the errant aircraft.

Demonstrate a system to accept and analyze large amounts of data and provide security interpretations in real-time to identify emerging trends of concerns.

Create data collection system for confidential, non-punitive reporting on aviation security through replication of the methodology, process, and philosophy used in the Aviation Safety Reporting System.

Demonstrate a biosensor and a chemical sensor for use onboard an aircraft.

# Technology Integration

**Technology Integration**

**OBJECTIVE**: (Safety & Security) Identify National Air transportation system safety and security vulnerabilities. Develop Program prioritization approach and criteria and assess the performance of the research areas against the program goals and objectives. TI will also develop approaches and methodologies to Accelerate system implementation onto all users and vehicle classes.

**Systems Engineering**

- Develop near and far term operational concepts that will enable a more secure aviation transportation system based on AvSEC product development
  - Product definition
  - Develop implementation risks and strategies
- Group products based on near and far term implementation probability

**Program Assessment**

- Risk assessment for aviation system
- Determine economic impacts with AvSEC relationships to Capacity and Mobility
- Develop aviation system decomposition for AvSEC

# Outline

- Program Overview
- External Coordination
- Current Safety Projects
- Security Projects
- **Future Safety Projects**

# NASA Aviation Safety R&D Planning Workshop

***Aviation Safety Planning Workshop***
***March 2-4, 2004***

***To solicit input from industry and other Government agencies for future projects in NASA's aviation safety research and development program***

**Working Groups recommend prioritized investments for FY 06-10**

**~300 Industry & Government participants**

**Working Groups (Reflect NASA strategic foci) for Safety R&D**

***Aircraft Self-Protection & Preservation***

***System Vulnerability Discovery & Mgmt***

***Environmental Hazards Awareness & Mitigation***

***Human Error Avoidance & Mitigation***

# Important Factors for New Safety R&D Planning

***Focus will shift to:***

- **"Revolutionary" technologies, as well as "retrofit"**
  - **Mix of next generation aircraft/technology/ATM and existing fleet**
  - **Potential dynamics of less-than-anticipated industry growth**
- **Safety factors associated with operation in the next-generation NAS environment (e.g., distributed Air/Ground ATM)**
- **Space-based communications, navigation, and surveillance**
- **Appropriate mix aircraft types (Transport, GA, R/C, cargo, supersonic, UAV, PAV…)**
- **Maintenance of the aging fleet**
- **New pilot demographics (more inexperienced, but more computer literate)**
- **Precursor risk assessment, not just past accident data**
- **Security synergies as well as potentially conflicting requirements**

# AvSSP Planning Horizon

- **NASA Program Review (September 2003)**
  - **“Bottom-up” planning**
  - **Based on WBS and objectives from the FY 2005 Budget Call**
- **FAA/NASA Project Reviews (November 2003)**
  - **Share status of Project Planning activities**
  - **Cross-agency check point**
- **Industry/OGA Planning Workshops (March 2004)**
  - **ASIST-like**
  - **Rely more on working groups (Security already up and going)**
- **Aeronautics Technology Subcommittee/Working Group Review**
- **NASA Strategy Team Review**
- **FY 2006 Submission--June 2004**
- **Industry/OGA Debriefing on final portfolio**
- **Non-Advocate Review (2005)**
- **Project Implementation in FY 2006**

# AvSSP Strategic Foci with Planned Safety Projects

- ***Aircraft Self-Protection & Preservation***

  *Focus: Protect and prevent damage to aircraft due to abnormal operations and systems failures*

  - **Aircraft & Propulsion Systems Self-Diagnosis and Self-Reliance (LaRC / GRC)**

- ***Environmental Hazards Awareness & Mitigation***

  *Focus: Detect and/or eliminate natural hazards that could compromise safe ATS operations*

  - **Icing Technologies for Regional Jets (GRC)**
  - **Satellite Data for Real-time Aviation Weather Forecast (LaRC / GRC)**

- ***Human Error Avoidance & Mitigation***

  *Focus: Prevent unsafe flight situations due to breakdown between human/machine interface*

  - **Integrated Presentation of Safety Critical Flight Deck Information (LaRC)**
  - **Training and Operations for Error Reduction (Ames)**

- ***Hostile Act Intervention & Protection***

  *Focus: Increase resiliency of the Air Transportation System against threats and hostile acts*

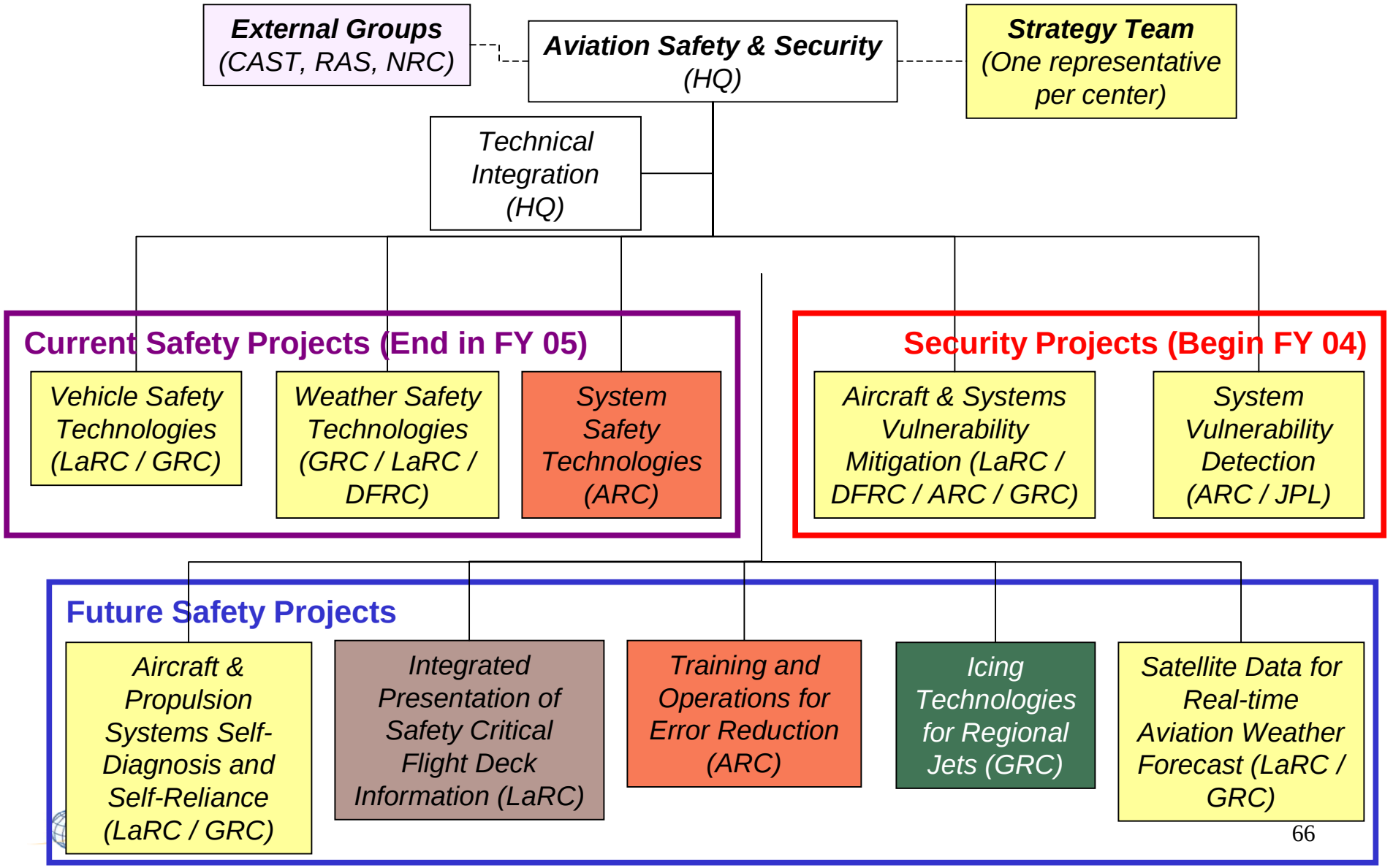
  - **Aircraft & Systems Vulnerability Mitigation (LaRC / DFRC / ARC / GRC)**

- ***System Vulnerability Discovery & Management***

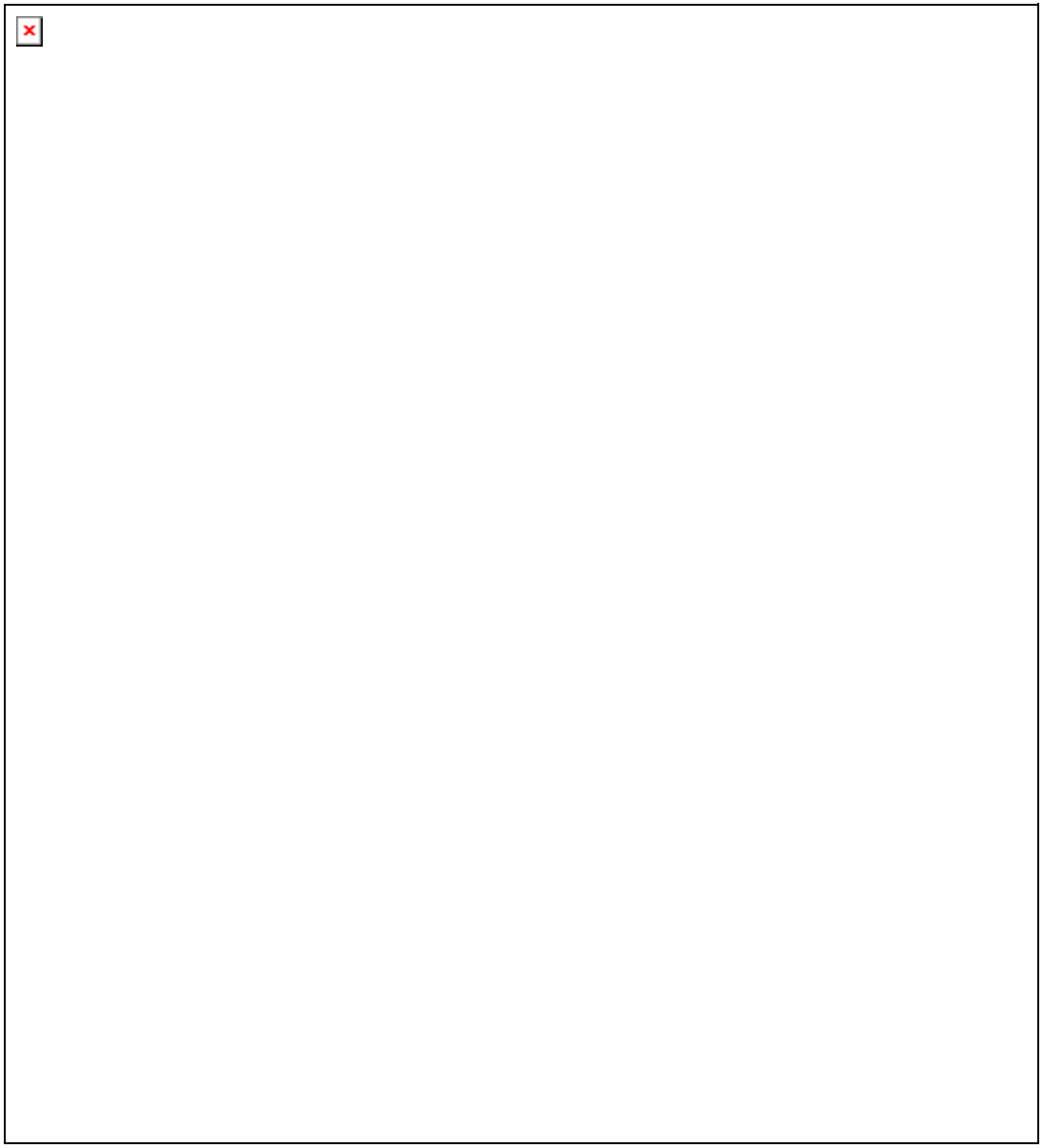
  *Focus: Identify and inform users of potential air transportation system vulnerabilities*

  - **System Vulnerability Detection (ARC / JPL)**
  - **Technical Integration (Program Office)**

# Aviation Safety & Security Program Structure



# AvSSP Total Program Budget Profile



# AvSSP Strategic Foci

**Human Error Avoidance**

ARC, LaRC

**Protecting Air Travelers and the Public**

**Aircraft Self-Protection & Preservation**

LaRC, GRC

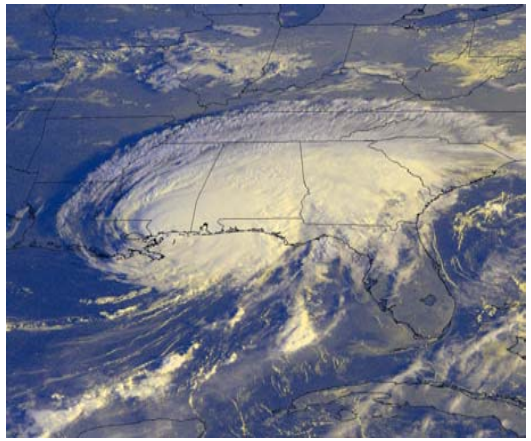
**System Vulnerability Discovery & Management**

ARC, GRC, LaRC, DFRC, JPL

**Hostile Act Intervention & Prevention**

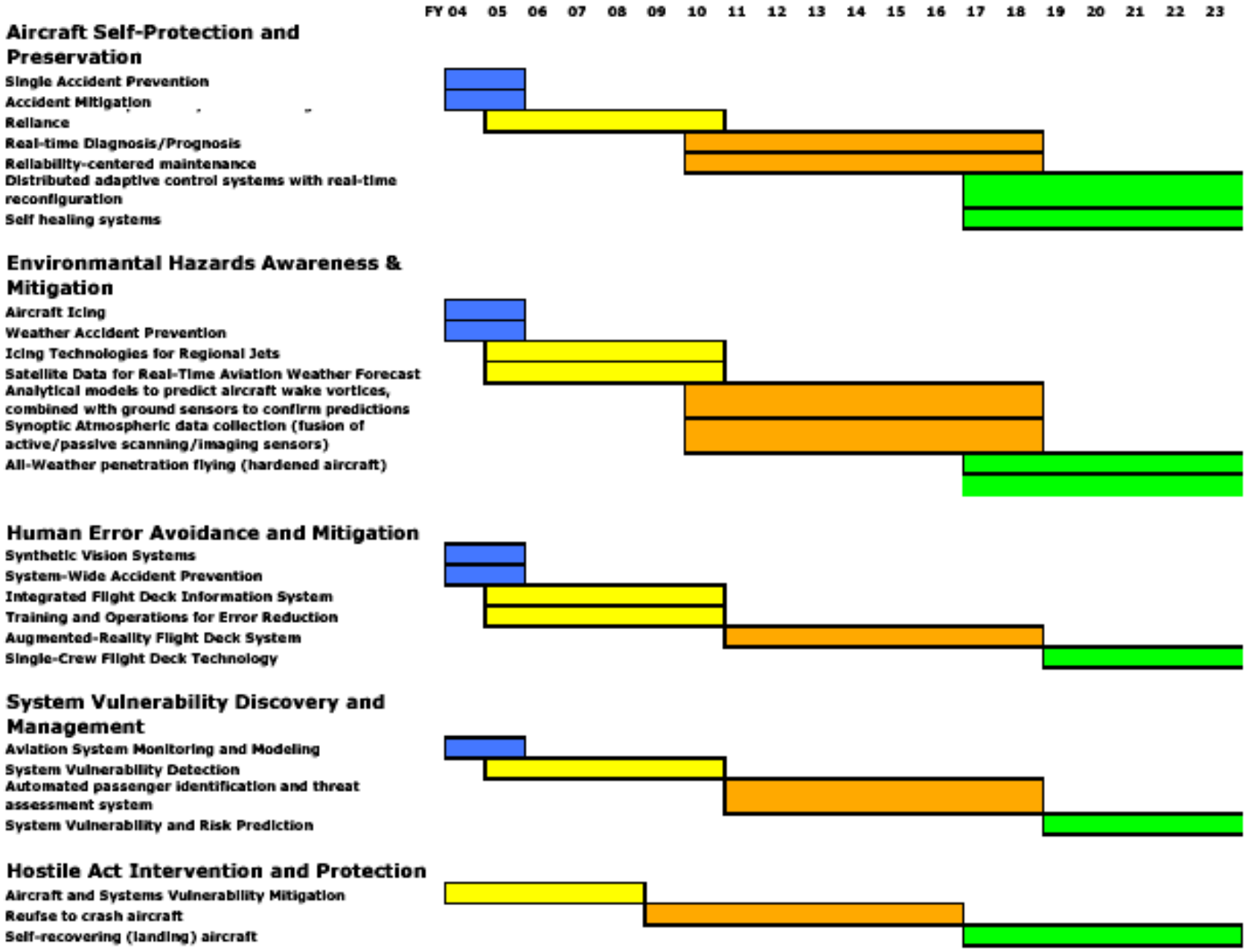

LaRC, GRC, ARC, DFRC

**Environmental Hazards Awareness & Mitigation**

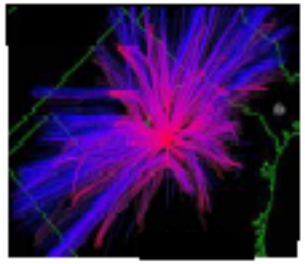


LaRC, GRC, DFRC

# Aviation Safety & Security Projects Roadmap

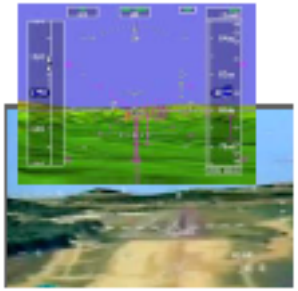


# AvSSP System Concepts



National System Assessment & Monitoring

Self-managing Aircraft



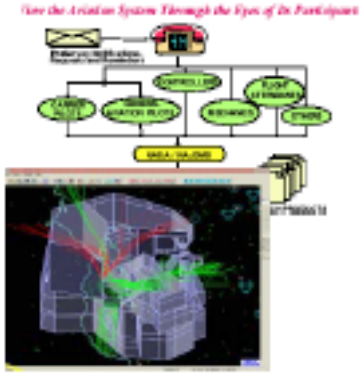
Synthetic Vision

Refuse-to-crash Aircraft

After-crash Survivable Aircraft

Human-error-resilient Systems

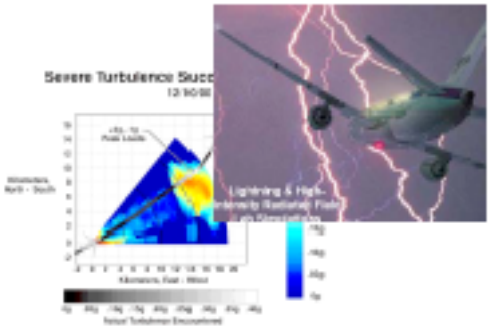
Pilot-centered Decision Toolkit



System Safety Forecasting and Analysis

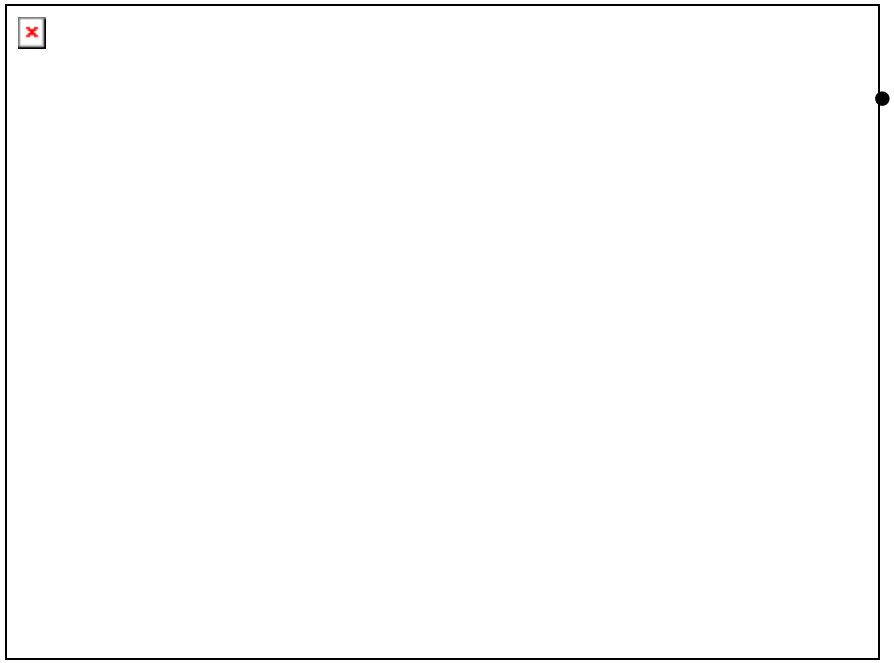
Integrated Security Functions

Hardened Aircraft & Systems



Weather Prediction and Threat Detection

# Plan for the Future



- **Continue to produce safety-enabling research products in cooperation with FAA and industry partners**
- **Implement aviation security effort**
- **Continue to take pro-active steps to assure technology transfer**

- **Initiate Safety R&D projects to start in FY 2006**
  - "Revolutionary" technologies, as well as "retrofit"
    - Mix of next generation aircraft/technology/ATM and existing fleet
    - Potential dynamics of less-than-anticipated industry growth
  - Safety factors associated with operation in the next-generation NAS environment (e.g., distributed Air/Ground ATM)
  - Space-based communications, navigation, and surveillance
  - All aircraft types (GA, R/C, cargo, supersonic, UAV, PAV,…)
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