Aviation Weather Information

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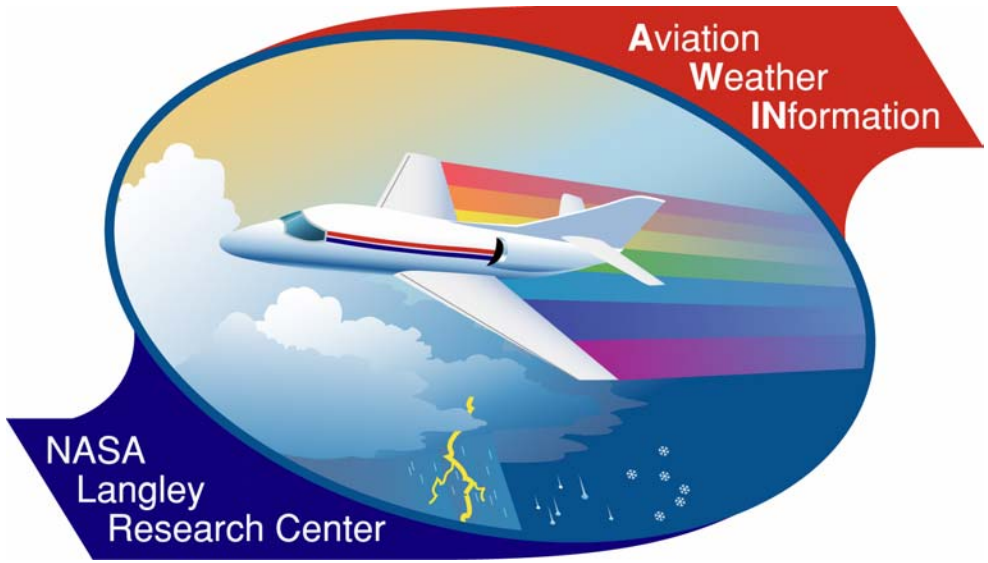


Background

Aviation Weather Information

- **Weather is a major contributing factor in accidents:**
  - **33% Commercial carrier**
  - **27% General aviation**
- **Many accidents are due to lack of weather situation awareness and poor decisions.**
- **Provision of strategic weather information during the en route phase enables avoidance of adverse conditions.**

Guidance

Aviation Weather Information

- **NASA Aviation Safety Program**
  - Aviation Safety Investment Strategy Team
  - Executive Council
- **National Aviation Weather Program Council**
  - National Aviation Weather Program Strategic Plan
  - National Aviation Weather Initiatives
- **FAA Safer Skies: Focused Safety Agenda**
  - Weather Joint Safety Analysis Teams
  - Weather Joint Safety Implementation Teams
- **FAA Aviation Weather Research Program**
- **Friends of Aviation Weather**
- **WxAP Project Review**

Plan

Aviation Weather Information

Goal

Develop technologies and methods for providing pilots with accurate, timely and intuitive information during the en route phases of flight which, if implemented, will enable a 25 to 50% reduction in aircraft accidents attributable to weather situation awareness

Objectives

- Develop Needed Weather Products and Sensing Capabilities
- Develop Enhanced Weather Presentations and Decision Aids

Challenges

- Improved Forecasts Need Better Input Data
- Existing Aircraft Need Retrofit Capability
- Pilot Workload Should Not Be Increased

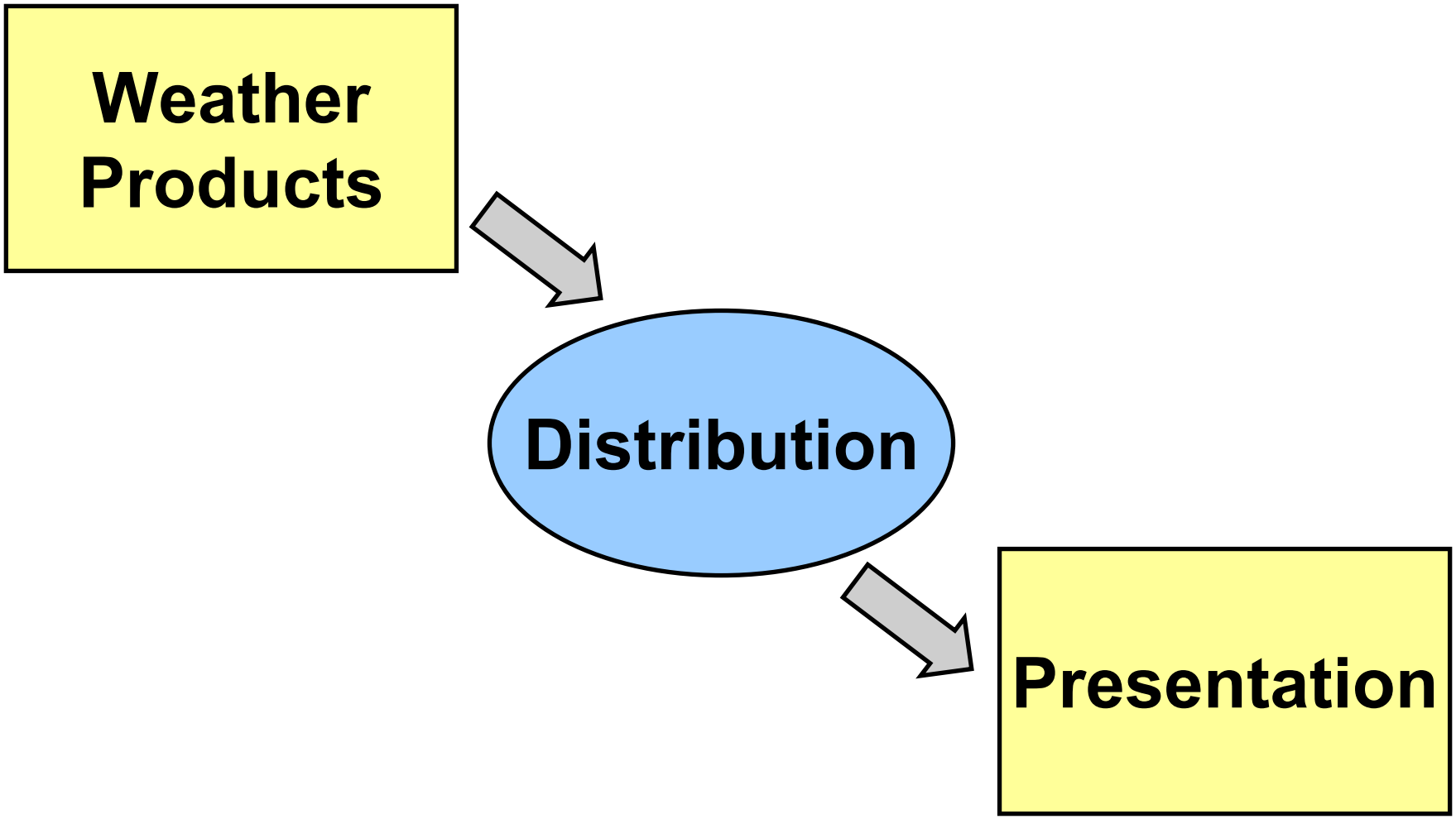
Diverse Aviation User Groups

Approach

- Use Aircraft as Airborne Weather Data Collectors
- Develop Multi-Purpose Sensor Systems
- Develop Installed and Portable Systems
- Provide Decision Aids

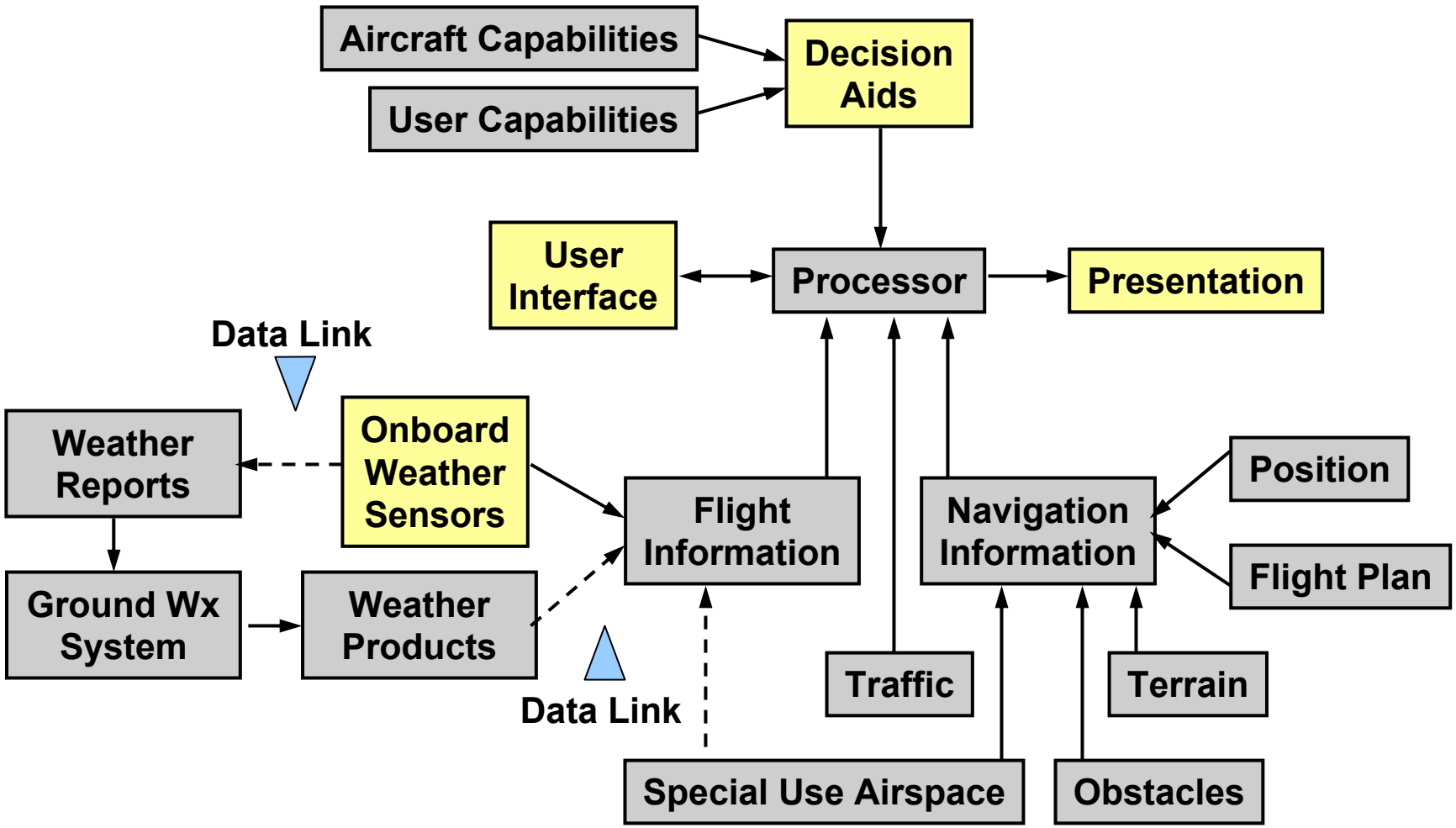
System Elements

Aviation Weather Information



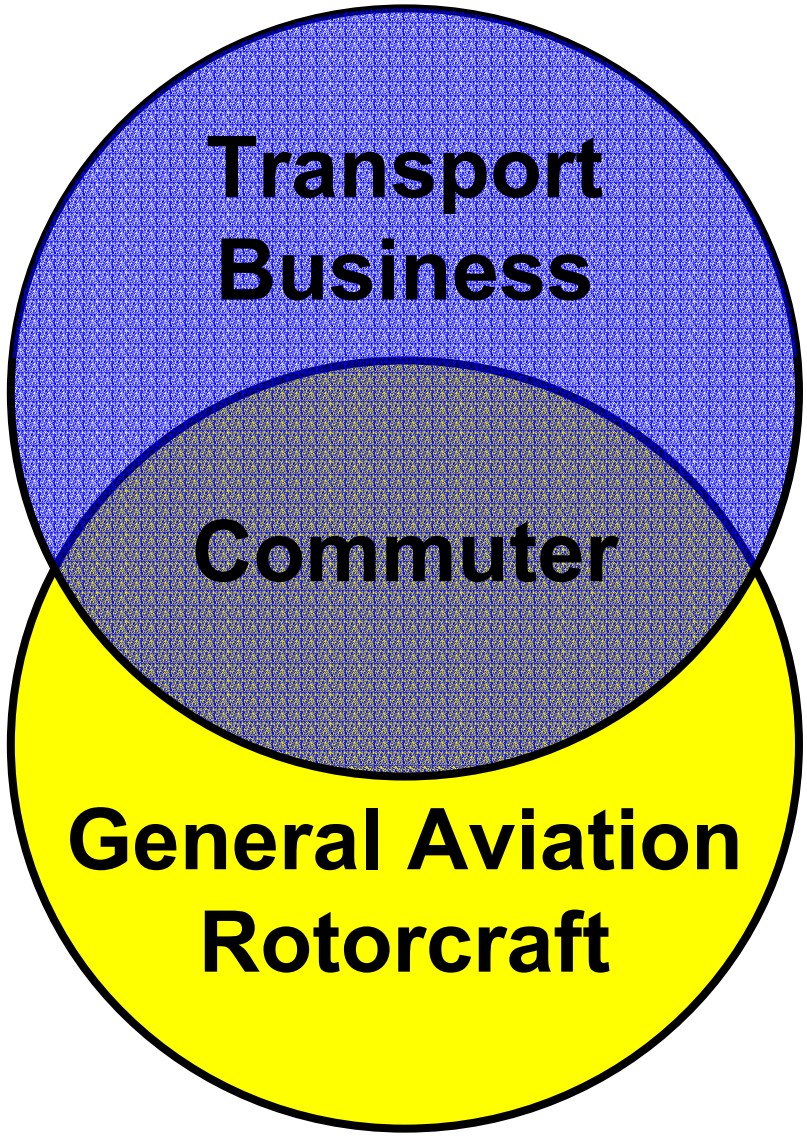
AWIN System

Aviation Weather Information



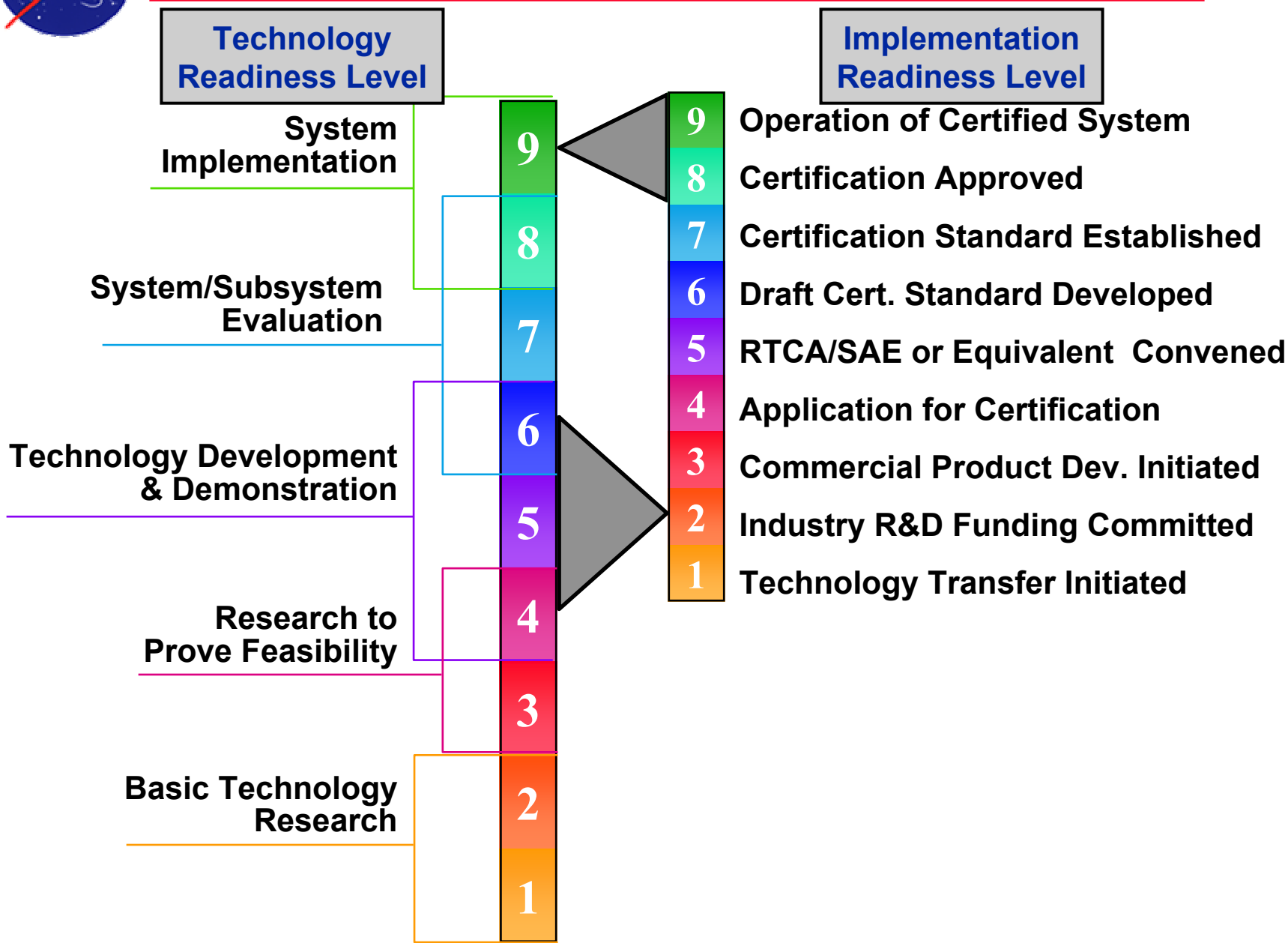
Market Segments

Aviation Weather Information



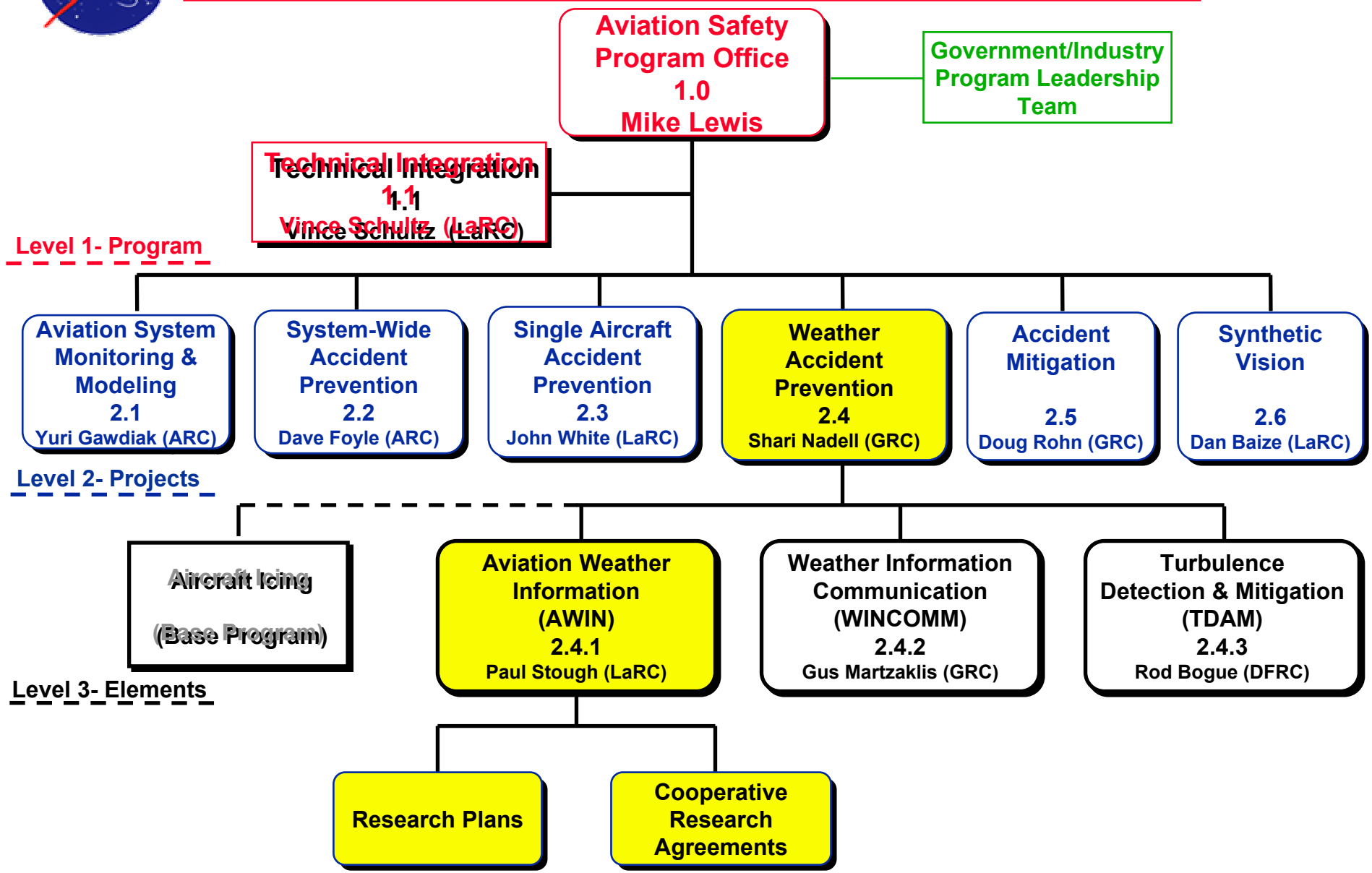
Technology Development Level

Aviation Weather Information



Aviation Safety Program Organization

Aviation Weather Information



Research Team

Aviation Weather Information

- **Dr. Jennifer Burt**
  Human Factors/Presentation
- **Mr. Jim Chamberlain**
  Flight Experiments
- **Mr. Taumi Daniels**
  Airborne Weather Sensing
- **Mr. Walt Green**
  Systems Engineering
- **Dr. Ed Johnson**
  Systems Engineering
- **Mr. Ken Jones**
  Flight Experiments
- **Dr. Jon Jonsson**
  Human Factors/Presentation
- **Dr. Kara Latorella**
  Human Factors/Decision Aiding
- **Dr. Ray McAdaragh**
  Human Factors/Presentation
- **Mr. John Murray**
  Meteorology
- **Dr. Robert Neece**
  Enhanced Weather Radar
- **Mr. Phil Schaffner**
  Airborne Hazard Processor

Mr. Paul Stough
Project Management

NASA Facilities

Aviation Weather Information

NASA C-206

General Aviation Work Station

NASA BE-200

Transport Research Flight Deck

NASA B-757

Partnerships

Aviation Weather Information

Flight Standards
Certification
Weather Policy
Weather Products
Flight Information Services

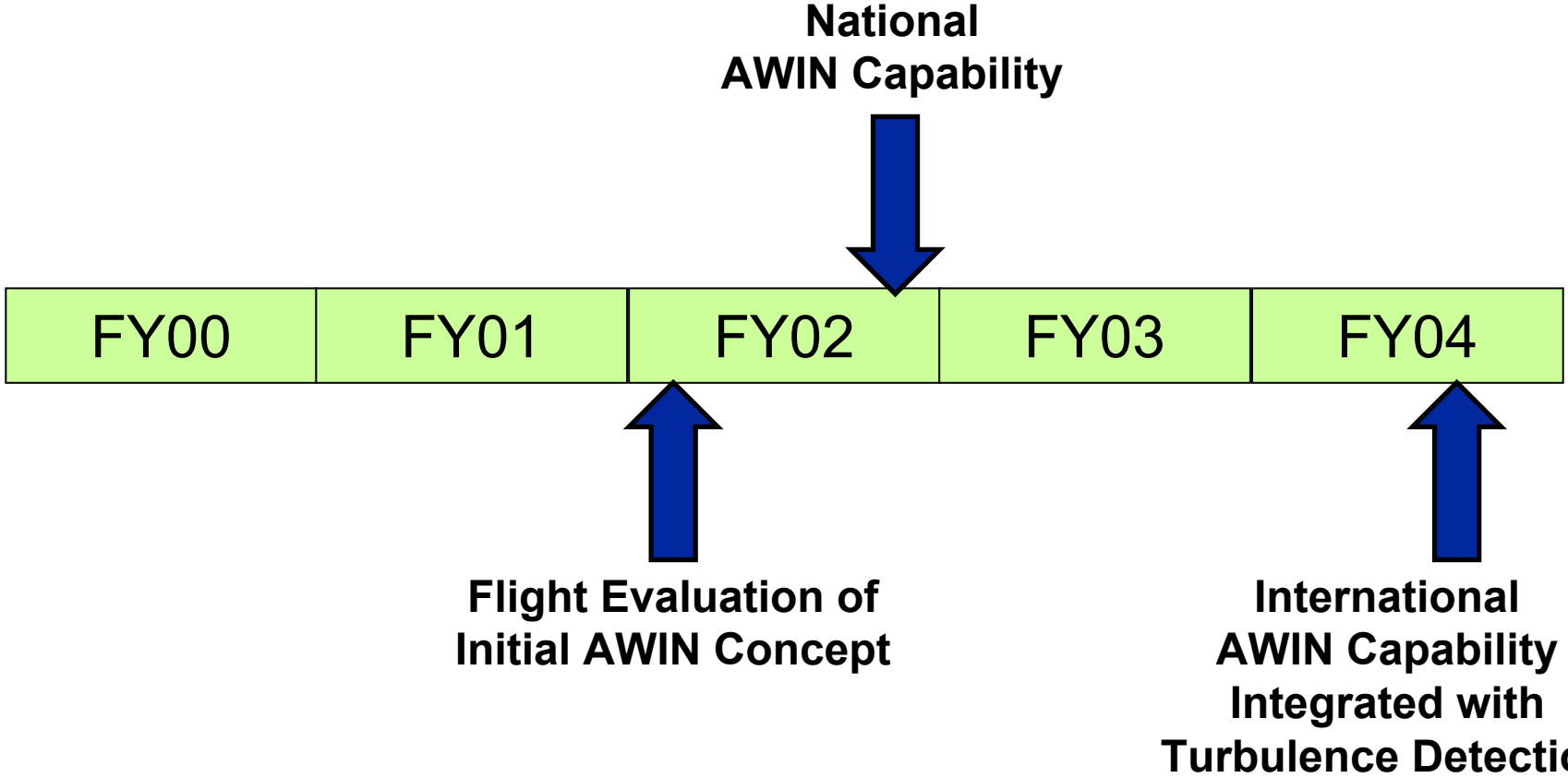
Aviation Weather Center
Forecast Systems Lab

Cooperative Research Agreements

Academia

Timeline

Aviation Weather Information



Current AWIN Technologies ⇨ **Next Generation AWIN Technologies**

Cooperative Studies with FAA

Aviation Weather Information

- **Human factors researcher assigned to the AWIN Team**

- **Enhancements to Flight Information Services Data Link (FISDL)**
  - Investigate effects of data-linked in-flight weather displays on pilot decision making and flight operations
  - Investigate the benefits and limitations of using time-delayed FISDL cockpit presentations with real-time airborne weather radar for Part 121 operations
  - Investigate feasibility of using cockpit access to FISDL in place of in-situ destination weather reporting for Part 135 operations
  - Define the cost considerations and incentives for aircraft owners to equip their aircraft and provide airborne weather reporting as part of a national implementation

Cooperative Research Efforts

Aviation Weather Information

- **Worldwide Transport Weather Information Systems**
  - Honeywell Weather Information Network
- **Nationwide General Aviation Weather Information Systems**
  - ARNAV
  - Honeywell
- **Elements of Weather Information Systems**
  - Honeywell — Weather Avoidance Using Route Optimization as a Decision Aid
  - Honeywell — Electronic Pilot Report (EPIREP) Generation and Datalink System
  - Rockwell — Aviation Weather Awareness and Reporting Enhancements
  - Rockwell — Enhanced On-Board Weather Radar
  - NCAR — Oceanic Convective Nowcasting Demonstration
  - NRL — Ceiling and Visibility Forecasting Improvements

Honeywell Weather Information Network

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Avionitek display in NASA B-757

Electronic Flight Bag in UAL Airbus

Technology Development

Honeywell Citation Jet
Honeywell simulator
UAL B-777 simulator
NASA B-757

In-Service Evaluation

United Airlines Spring 2001

ARNAV General Aviation System

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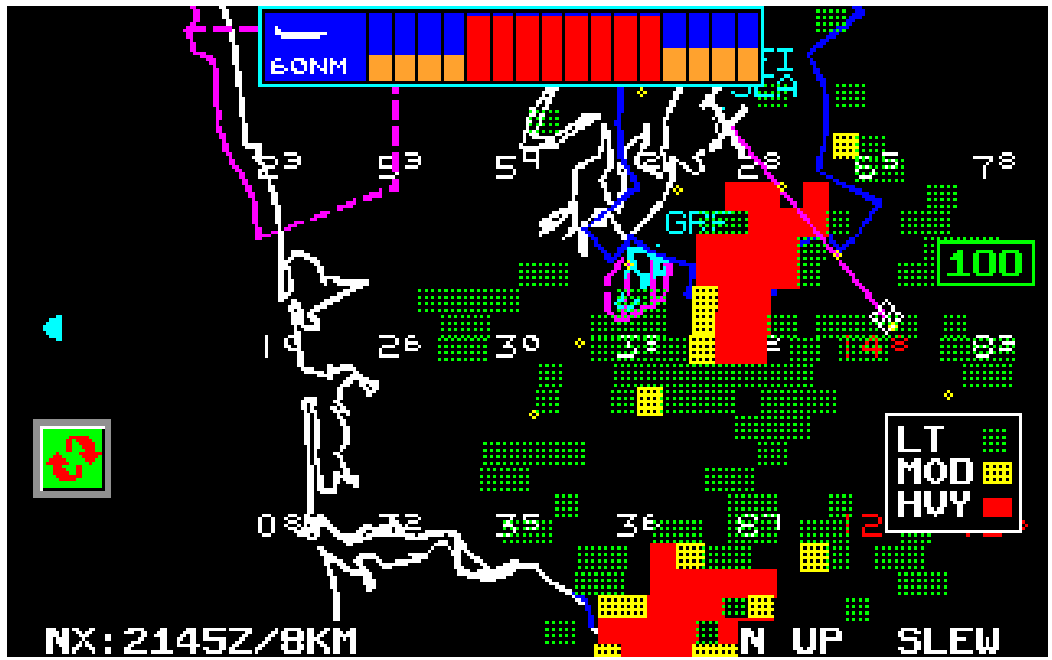
Display Retrofit to Existing Cockpit

Display Incorporated in New Cockpit



Weather Display with Look-ahead Terrain Window

8km NEXRAD

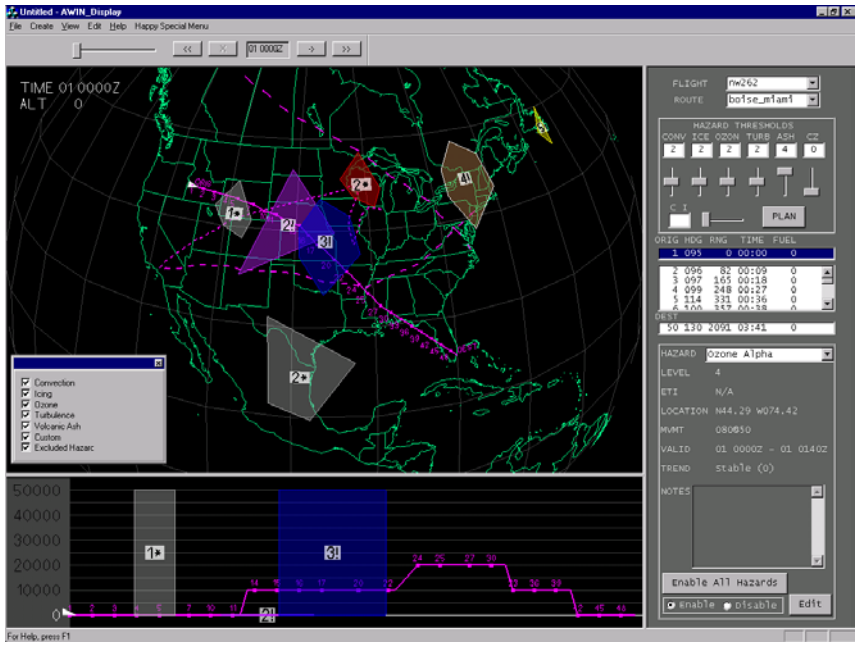
100 nautical mile scale

Aircraft flying at 11,500 feet MSL

Honeywell Route Optimization Tool

Aviation Weather Information

Evaluation by AOC in 2002



User-Centered Interface

Weather hazards, depicted as polygons (top) and as corresponding columns (at bottom), overlaying candidate flightpaths facilitates 3D routing

Calculations provided for fuel burn and ETA for direct, wind-preferred, and hazard-avoiding routes

Users can manipulate acceptable hazard levels and define other hazard regions.

Scaleable Map

Airborne Weather Reporting

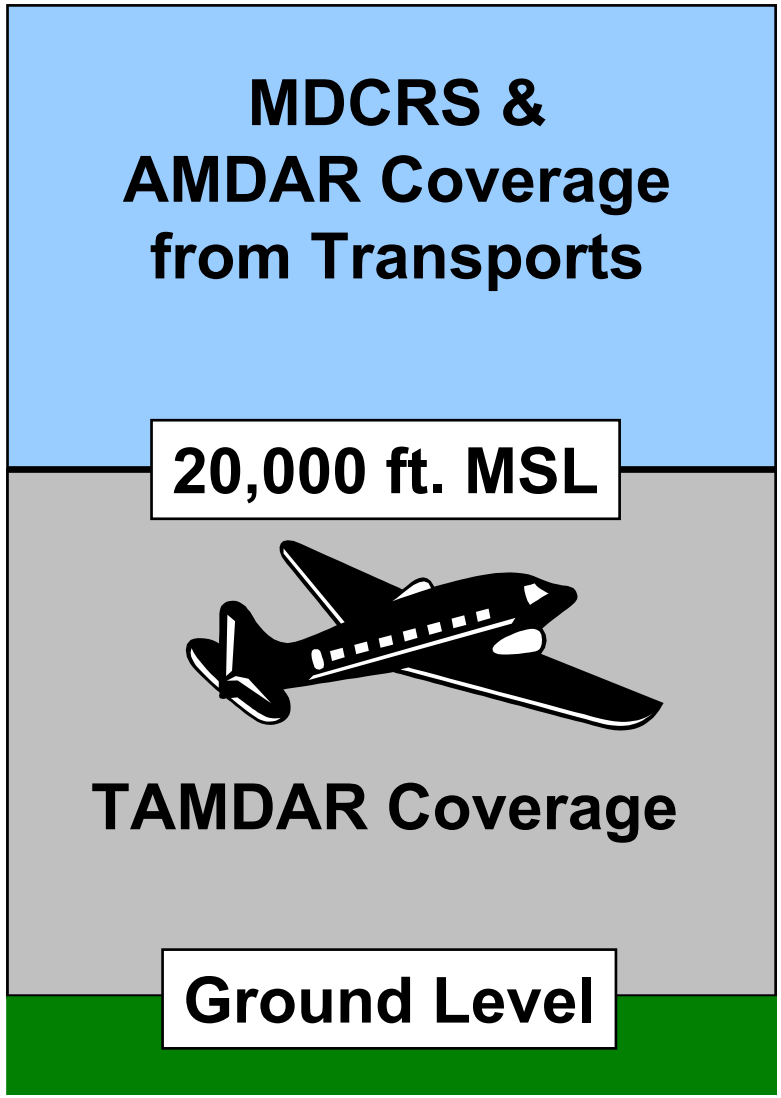
Aviation Weather Information

Use aircraft operating below 20,000 ft altitude to sense and report

- Moisture
- Temperature
- Winds

to be used by

- Forecast models
- Weather briefers
- Controllers
- Other aircraft



Rockwell Preflight Briefing Tool

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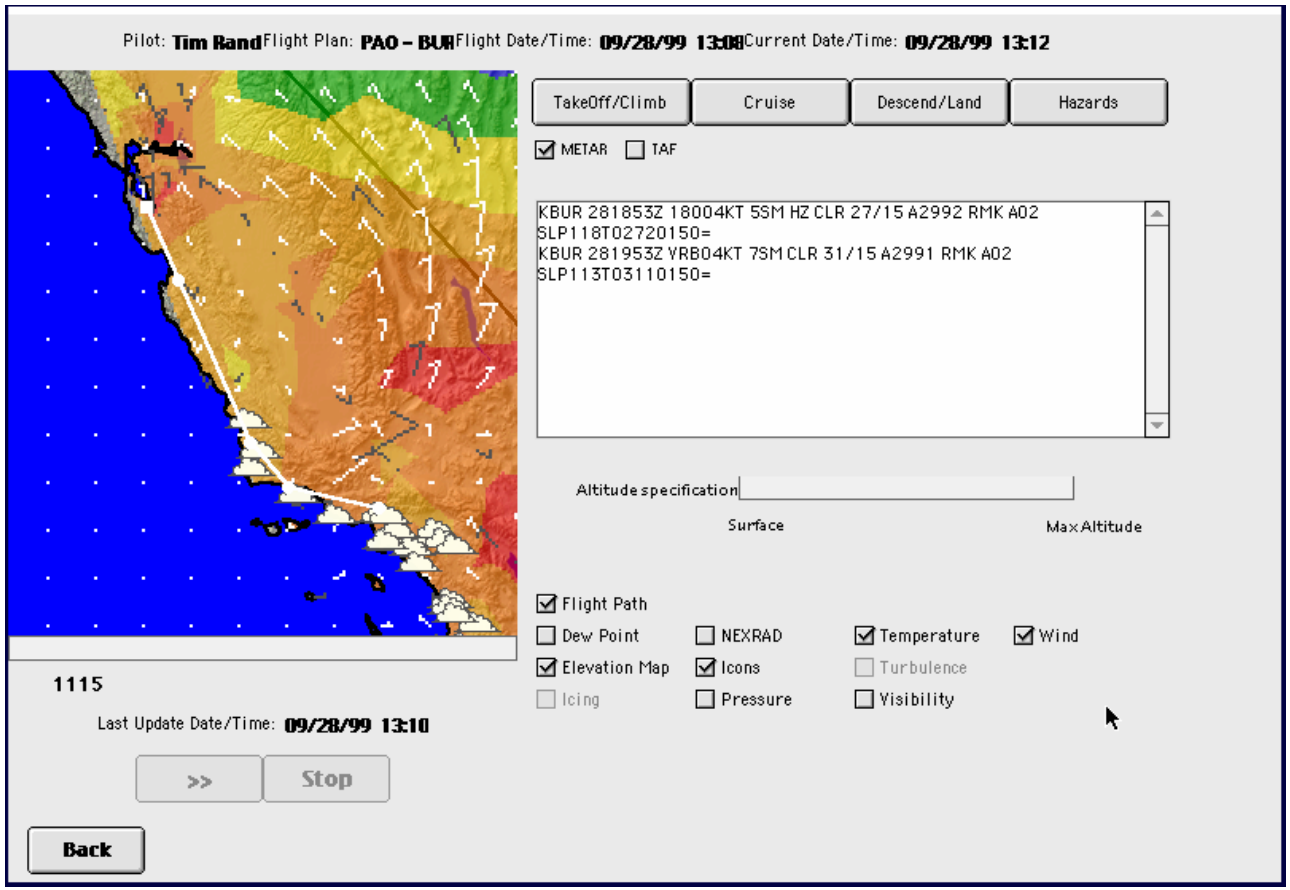
Completed VFR tool; started IFR tool development

Briefing for flight from Palo Alto, CA to Burbank, CA

Temperature, wind and cloud overlays are mapped onto specified route.
Cloud cover is presumably due to the typical California coastal fog.



Real-time graphic and text-based weather information customized for a specified flight plan

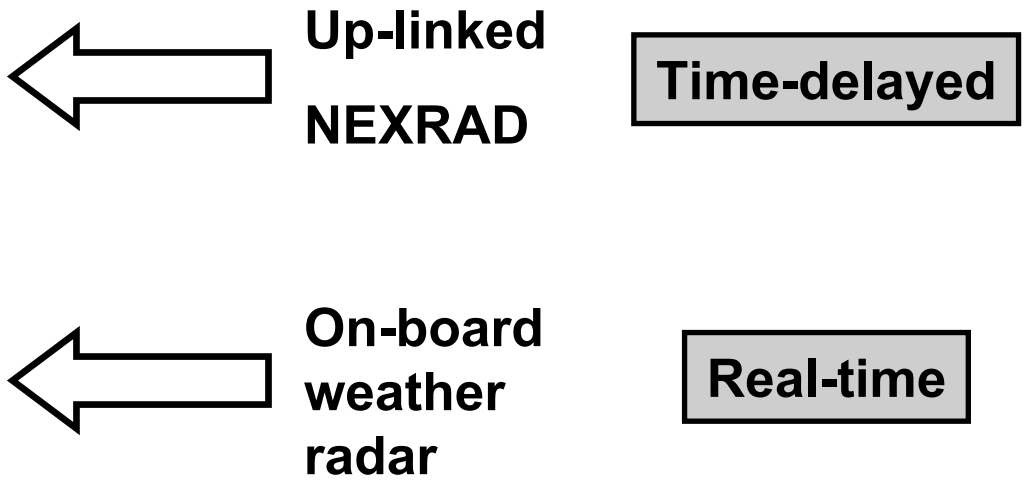
Probability of mission success based on pilot and airplane capabilities

Rockwell Enhanced Weather Radar

Aviation Weather Information

Address combining tactical and strategic information

Evaluation on NASA B-757

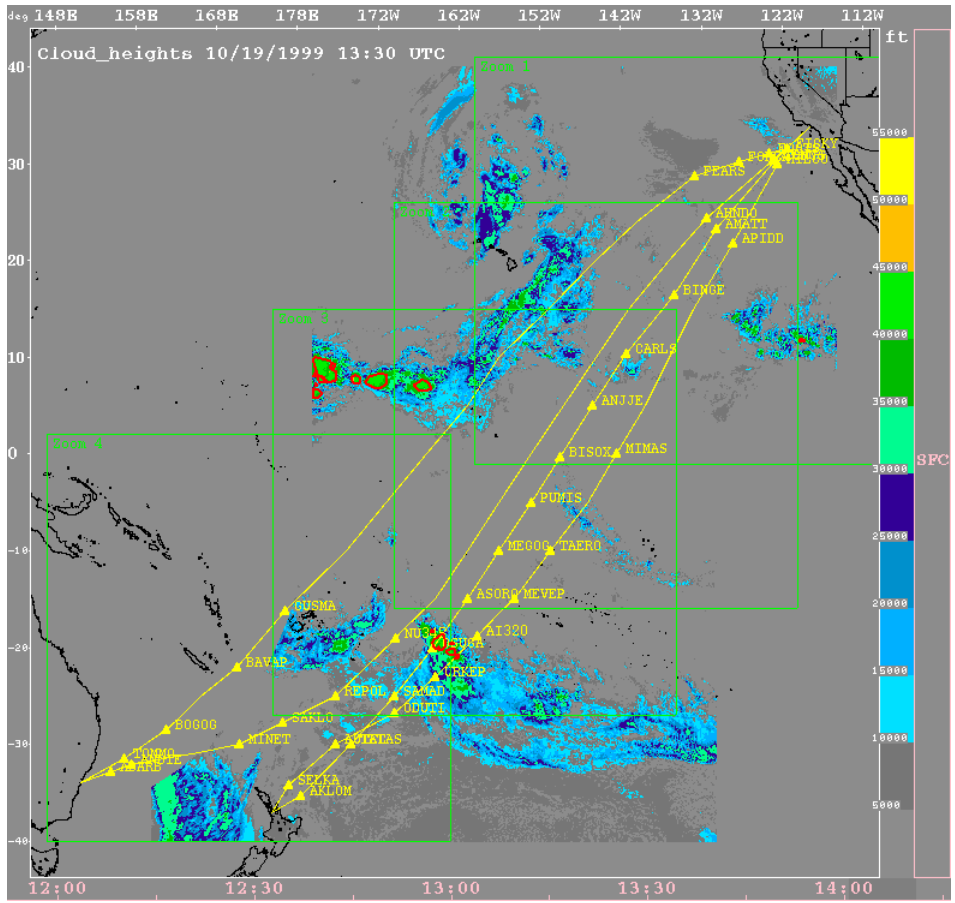


Display Concept

Automated algorithms process satellite data to provide timely summary of weather hazards to airline dispatch, air traffic control, and crews of en-route aircraft

United Airlines 747-400

747-400 Cockpit



High-Resolution OCND Weather Product

Flight Information Services Data Link (FISDL) Display Evaluations

General Aviation Cockpit Research

Convective Weather Sources (CoWS) Experiment

BE200 Super King Air, NASA Langley

Workload and Relative Position (WaRP) Experiment

Cessna 206, NASA Langley

Studying the effects of data link weather displays on pilot decision performance

Guidance for manufacturers

Advice for pilots on how best to use the technology

General Aviation Cockpit Research Facility

RTI Team

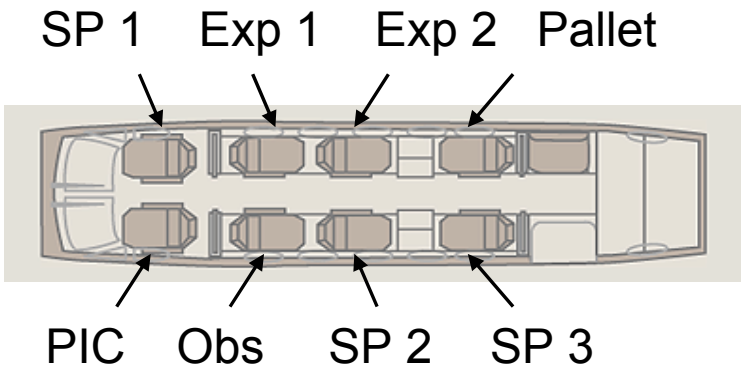
Experiment #1 (NASA CR in publication)
- Weather depiction
- Data latency

Experiment #2 (NASA CR in review)
- Ownship position symbology
- NEXRAD cell size resolution

Experiment #3 (in design)
- Trending (Looping of NEXRAD)
- National Convective Weather Forecast

Evaluation of pilot weather awareness and decisions with different weather sources

NASA BE200
Super King Air



Experiment Conditions

- 12 IFR subject pilots (SP)
- Pilot-not-flying tasks
- Convective weather scenario
- Differing weather sources:
  audio, visual scene, AWIN
- With “present position” symbol
- Tethered display

Status

- Initiated Summer 2000
- Completion in Summer 2001

Exploration of the effects of flying workload and display position on pilot performance and aircraft control

NASA Langley Cessna 206

Differing AWIN Display Positions

Experiment Conditions

- GA subject pilots flying
- Clear weather scenario
- Low/high flying workloads
- With/without conventional & AWIN Wx data acquisition
- Differing display positions

Status

- Fly Spring & Summer 2001

Initial recommendations defined for future AWIN display systems' software and hardware

CT-1000

FliteVue 640

StratoCheetah Flight Manager III

Nav-2000

Polaris GPS 990

Software packages

- Jeppesen's FliteMap
- Echo Flight's EchoMap

Input devices

- Bezel buttons
- Touch pad
- Alphanumeric keyboard
- Arrow keys
- "Mouse" keys
- Touch screen

Old Dominion University

ackground:

- Current systems require significant attention (heads-down time)
- Voice recognition may significantly reduce heads-down time & workload

bjective:

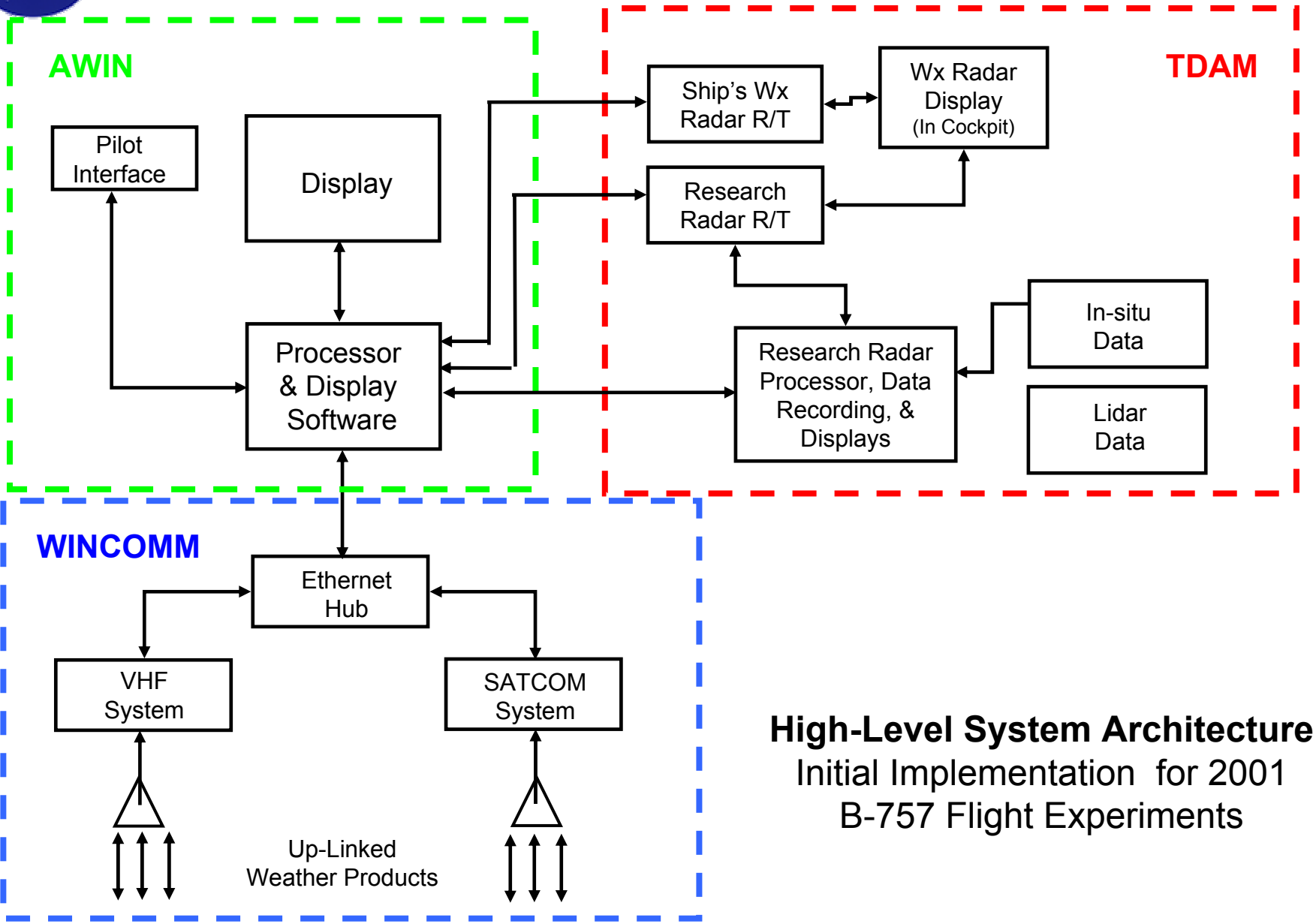
- Address issues of using voice command and control of FISDL-type weather information systems (accuracy in a high noise environment, vocabulary, menu structure automation, hybrid interface systems, effect on workload, and improvements in weather situation awareness)

pproach:

- Conduct simulations and flight experiments
- Utilize advances of military, automotive and information technology industries

esults:

- Improved human-machine interface technologies that reduce workload and human error
- Guidelines for operational use of voice interfaces with graphical weather information systems



High-Level System Architecture
Initial Implementation for 2001
B-757 Flight Experiments

- Old Dominion University - TAMDAR Incentives Study
- Old Dominion University and Virginia Tech - Auto/Trucking Technologies
- Concept of Operation
- Requirements

OLD DOMINION UNIVERSITY

1872 VirginiaTech
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

- **Aviation Weather Information Systems Research and Development**: SAE Paper No. 1999-01-1579, April 1999.
- **Aviation Weather Information Requirements Study**: NASA CR-2000-210288, June 2000.
- **Reducing Aviation Weather-Related Accidents through High-Fidelity Weather Information Distribution and Presentation**: ICAS Paper No. ICAS 2000-6.5.1, August 2000.
- **Assessment of the Effects of Delayed Weather Information Datalinked to the Cockpit on Pilot Navigation Decision Making**: IEEE AIAA DASC Paper No. *Daniel E. Yuchnovicz, Malcolm A. Burgess, Michael L. Heck, and Paul F. Novacek; Research Triangle Institute, Hampton, Virginia;* Alan F. Stokes, Rensselaer Polytechnic Institute, Troy, New York
- **Decision-Making In Flight with Different Convective Weather Information Sources: Preliminary Results**:
- **Cognitive Task Analysis of Business Jet Pilots' Weather Flying Behaviors: Preliminary Results**: NASA TM (in publication)
- **Use of Data-Linked Weather Information and the Effects on Pilot Decision Making in a Piloted Simulation Study**: NASA CR (in publication)
- **The Effects of Ownship Information and NexRad Resolution in Use of a Weather Information Display**: NASA CR (in publication)

- Easier access to aviation weather information
- More intuitive presentation of information to flight crew
- Better situation awareness
- Faster, more informed decisions
- Safer and more efficient flights