High Resolution Data Needs of NASA's Aviation Safety Program's Synthetic Vision Systems Project

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NASA Langley Research Center

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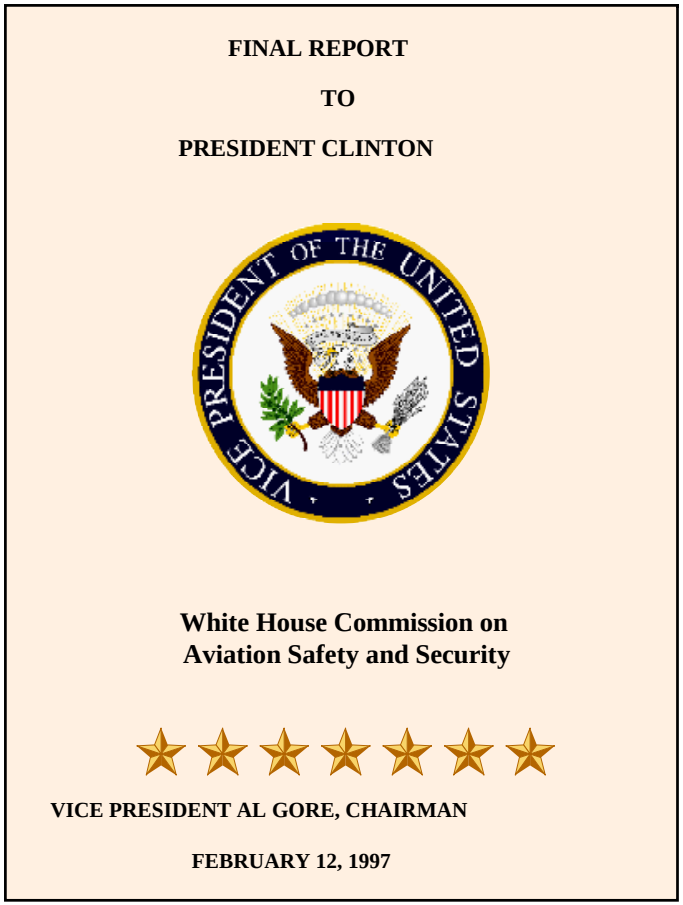
Outline

- Synthetic Vision Systems defined
  - Flight tests
  - Simulator tests
- Deployment
  - Standards
  - Certification
- Spin-offs

Call for Action

Aviation Safety Program: Synthetic Vision Systems


FINAL REPORT

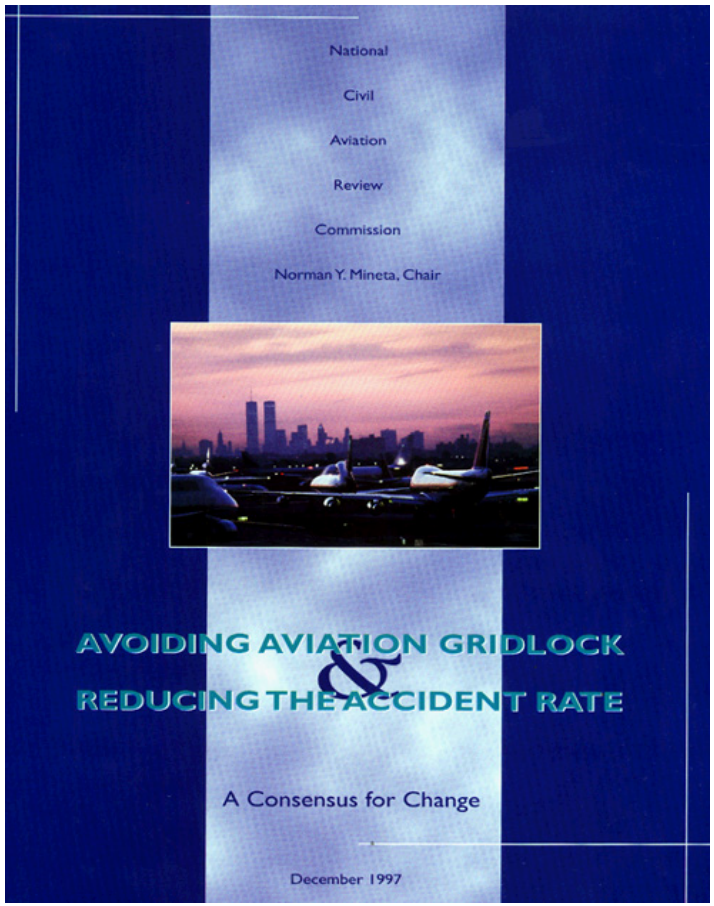
TO

PRESIDENT CLINTON

White House Commission on
Aviation Safety and Security

VICE PRESIDENT AL GORE, CHAIRMAN

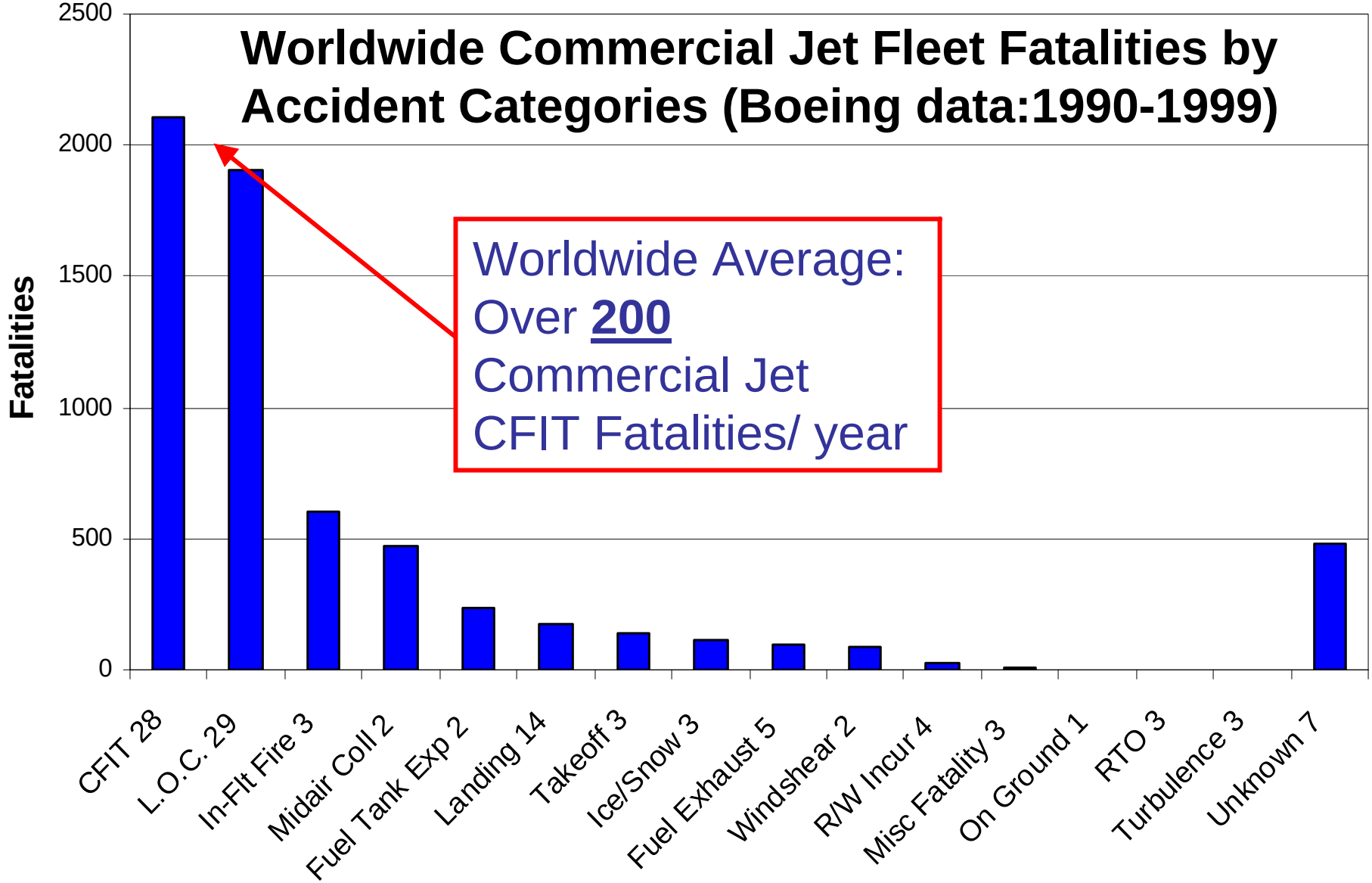
FEBRUARY 12, 1997



"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

CFIT- the #1 Killer in Commercial Aviation

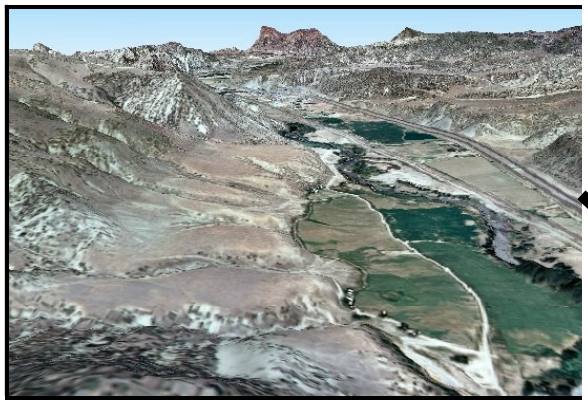


As of February 10, 2003

- FAA Notice of Proposed Rulemaking (NPRM)
  - Docket No. FAA-2003-14449; Notice No. 03-03
  - Federal Register/ Vol. 68, No. 27
- A synthetic vision image is a computer-generated image of the external scene topography from the perspective of the flight deck that is derived from aircraft attitude, high-precision navigation solution, database of terrain, obstacles, and relevant cultural features.
- A Synthetic Vision System is an electronic means to display a synthetic vision image of the external scene topography to the flight crew.

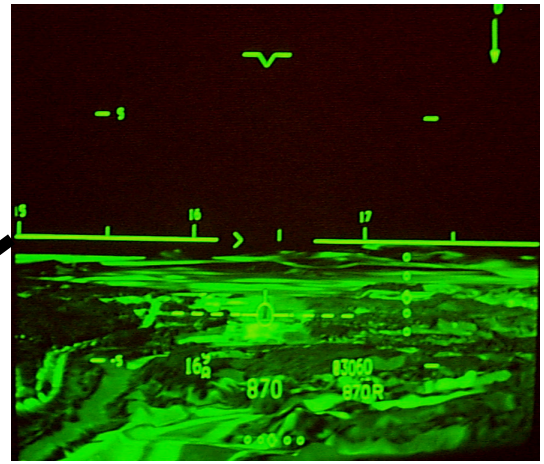
NASA's Synthetic Vision System Components

A database derived system utilizing precise GPS navigation & integrity-monitoring sensors (as required) to provide a **unrestricted synthetic view** of the aircraft's current external environment, regardless of weather or time of day

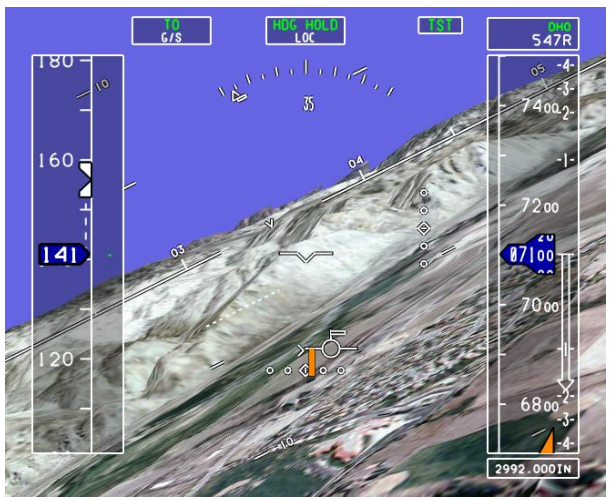


Worldwide Terrain, Obstacle & Airport Databases

IRS / GPS (LAAS/ WAAS)



Advanced Sensors for Database Integrity & Object Detection



Real-time Synthetic Vision Display w/ Advanced Guidance

Real-time tactical hazards (Wx, NOTAMS)

Relevant Traffic Data (TCAS, ADS-B, TIS-B)

Example Synthetic Vision Equipped Flight Deck

Aviation Safety Program: Synthetic Vision Systems

SVS Flight Tests

- Asheville, NC (1999)
  - Photo-real SVS concepts
- Dallas-Ft. Worth, TX (2000)
  - Photo-real SVS concepts, Runway Incursion Prevention System display, Hold-Short Advisory Landing Technologies
- Eagle, CO (2001)
  - Photo-real SVS concepts
- Roanoke, VA (2002)
  - General Aviation SVS concepts
- Reno, NV (2003)
  - Photo-real SVS concepts

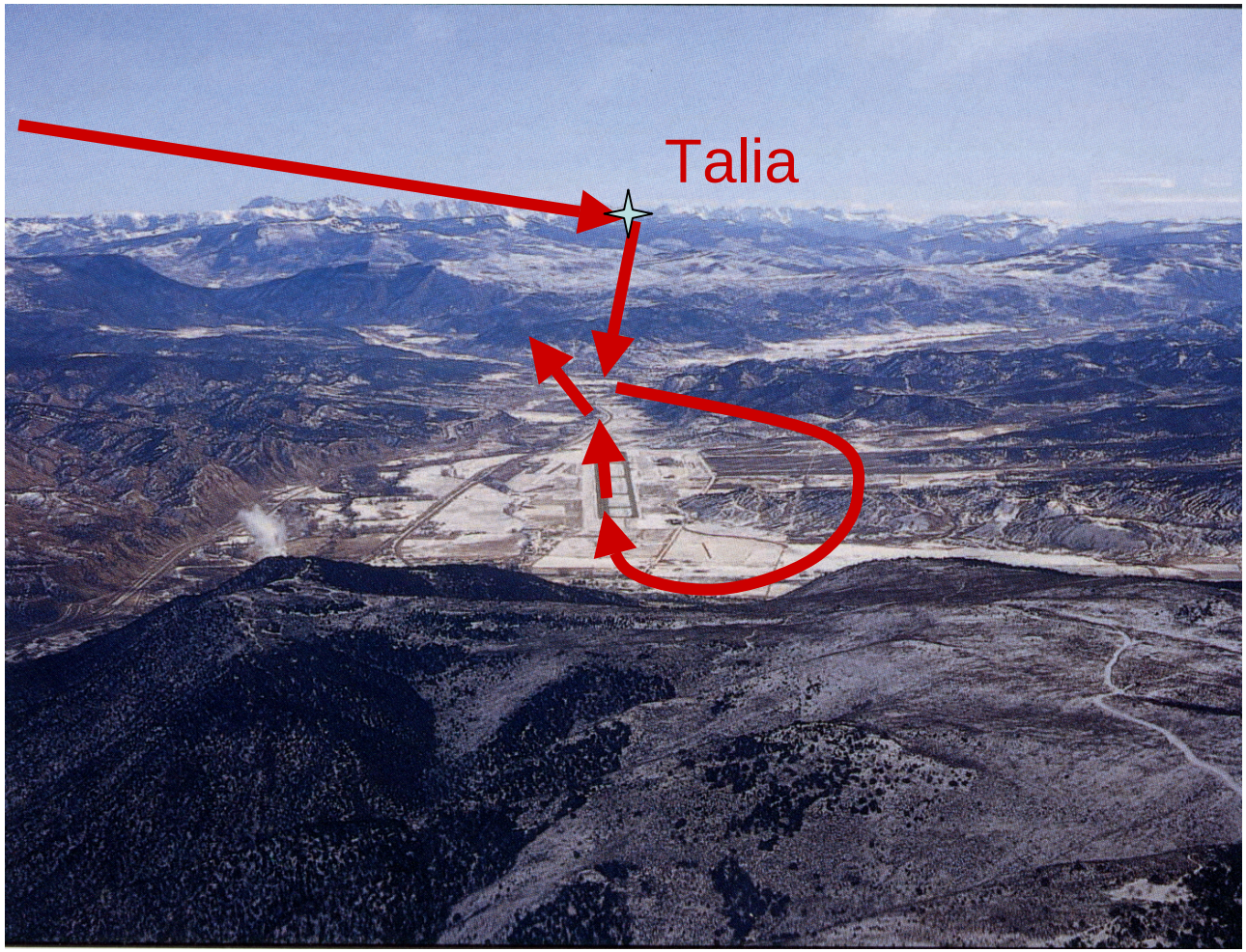
SVS EGE-2001 Flight Test Statistics

Aviation Safety Program: Synthetic Vision Systems

- 106 Approach and Departure Runs
  - 87 NASA Runs
    - 52 Visual Arrivals to Runway 07 with KREMM Departures
    - 35 FMS25 Arrivals with Cottonwood 2 Departures
- 7 Evaluation Pilots
  - Boeing (2), FAA, United, Delta, American, NASA

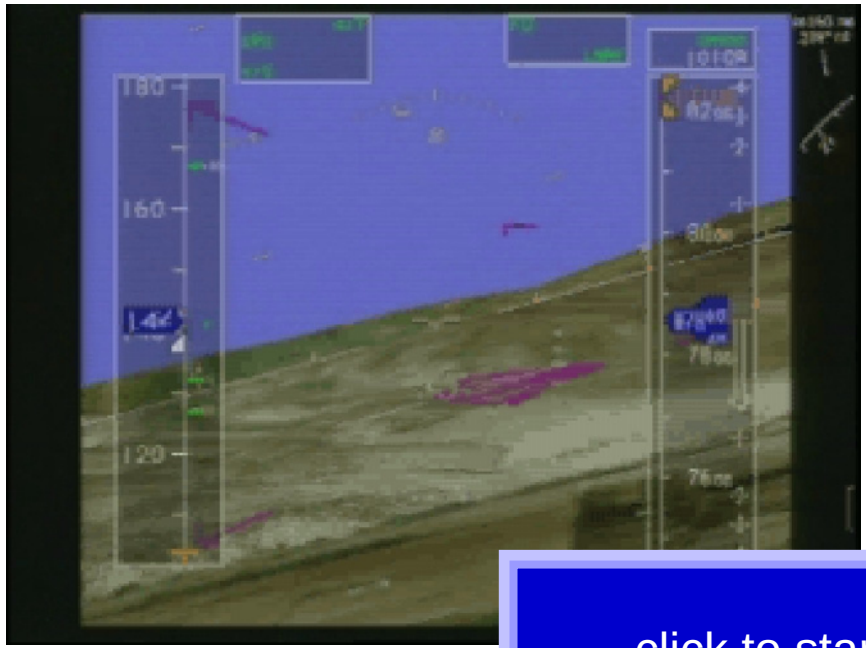
SVS EGE Flight Test – Runway 7

Aviation Safety Program: Synthetic Vision Systems



SVS Flight Test – Circling Approach to EGE Runway 7

Aviation Safety Program: Synthetic Vision Systems



click to start movie clip

SVS Display – EGE Flight Test

Aviation Safety Program: Synthetic Vision Systems

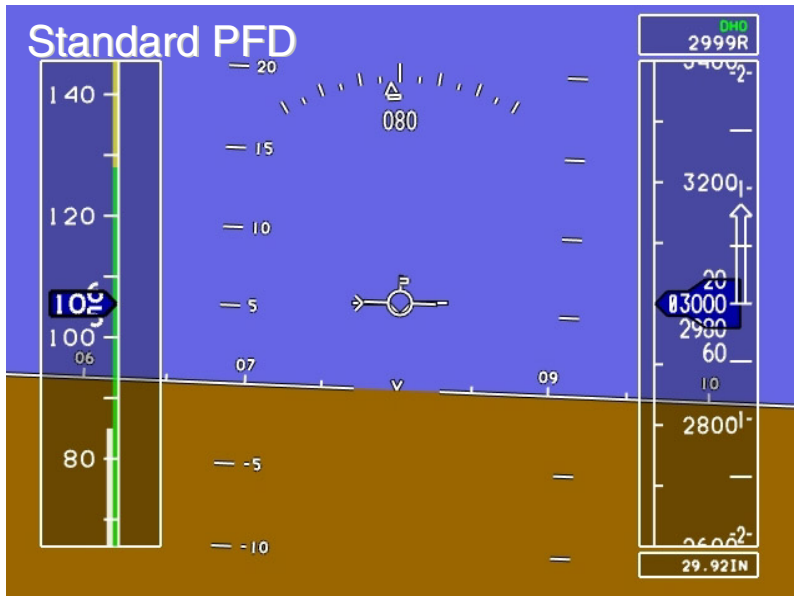
link to movie clip (32 MB, requires Internet connection)

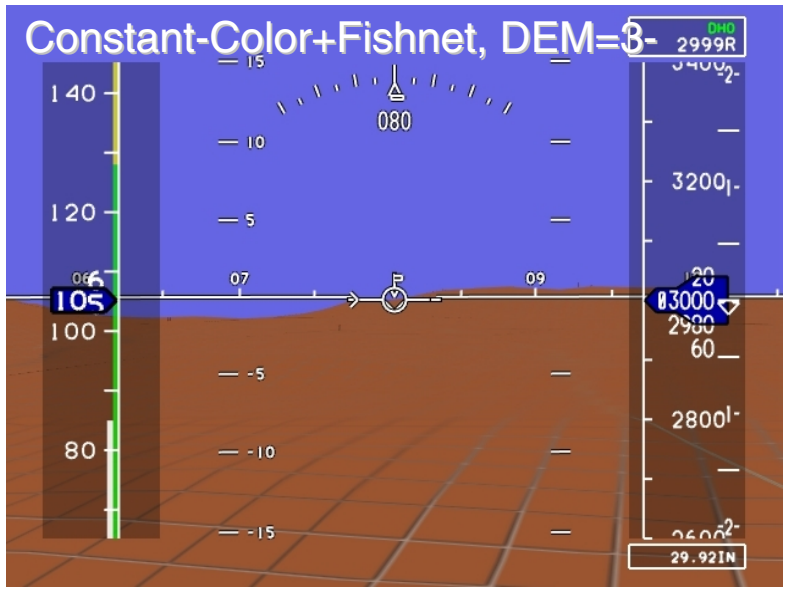
SVS General Aviation Simulation/Flight Tests

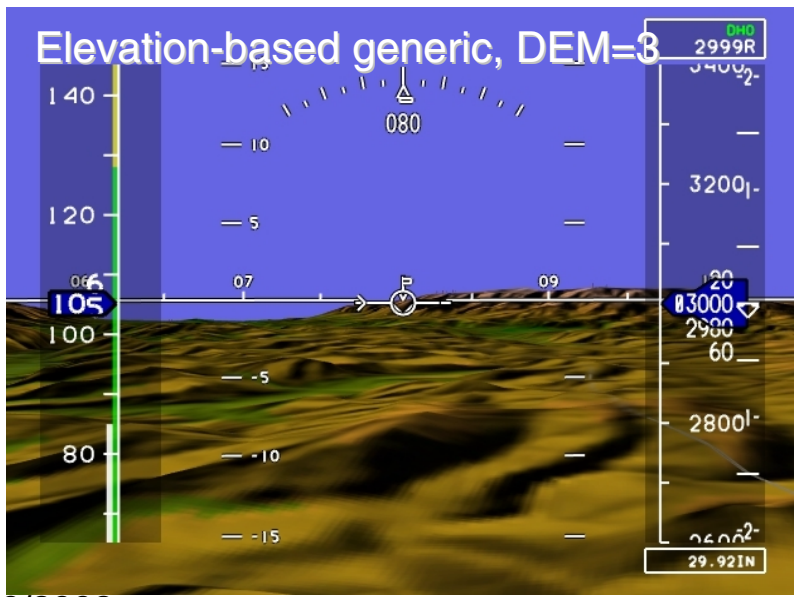
- Terrain Portrayal – Head Down Displays
  - Variety of terrain skins tested
    - 1, 3, and 30 arcsec terrain models
    - photo-realistic, elevation-based generic, blue-over-brown textures
    - with and without a constant spaced fishnet overlay
- Symbology Development – Head Down Displays
  - Variety of terrain skins tested
    - 1 arcsec terrain with photo-real texture
    - 3 arcsec terrain with elevation-based generic texture
    - 30 arcsec terrain with constant color and fishnet overlay
- Simulator tests require out-the-window terrain models
  - Use best data available (IFSAR, NED, Photo-real)

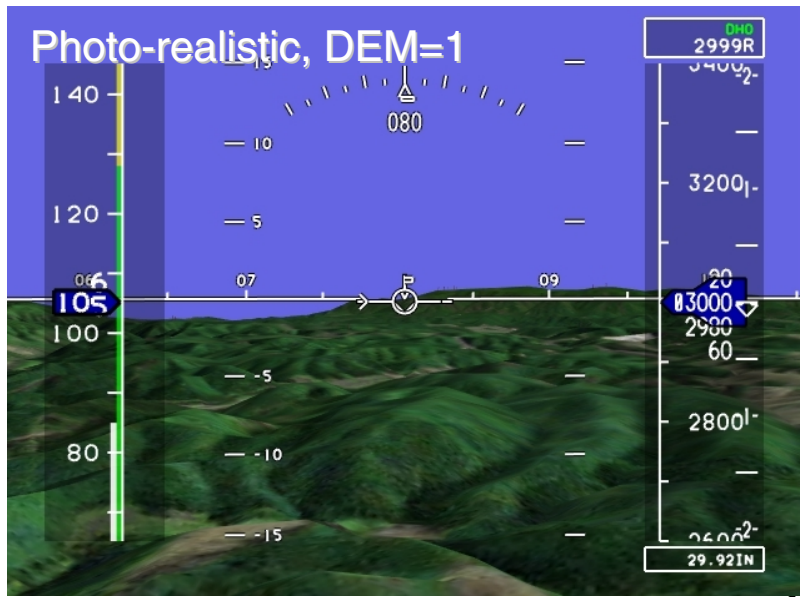
NASA General Aviation SVS Terrain Concepts

Aviation Safety Program: Synthetic Vision Systems



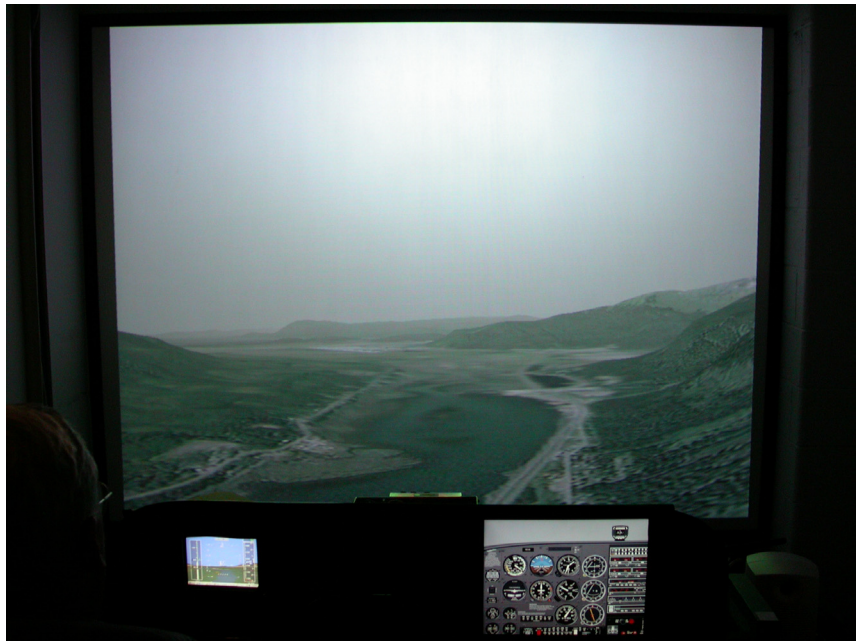






Simulator Experiment – Juneau, AK

Approaches, Missed Approaches, Maneuvers

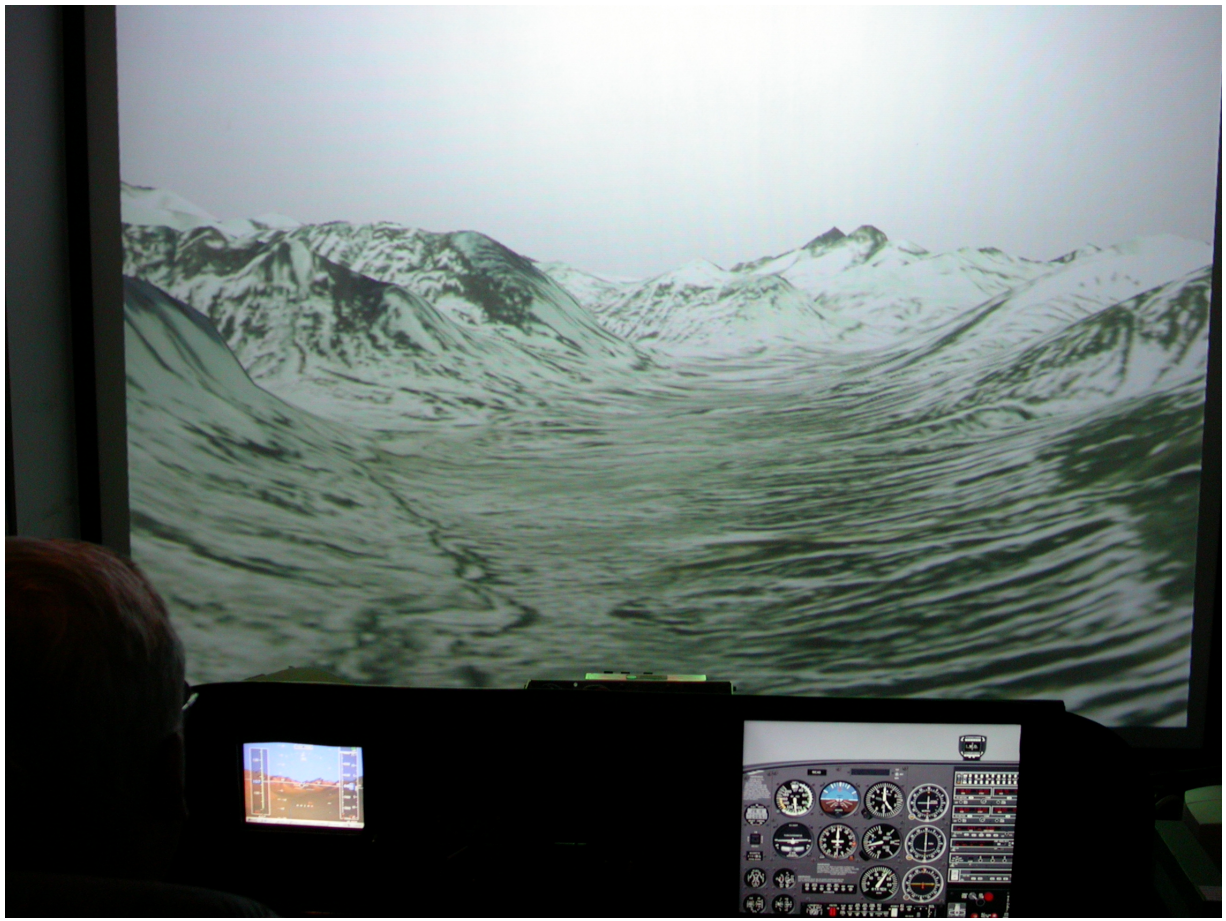


Datasets include:

site survey, aerial photogrammetry, IFSAR DSM, NED

Simulator Experiment – Merrill Pass, AK

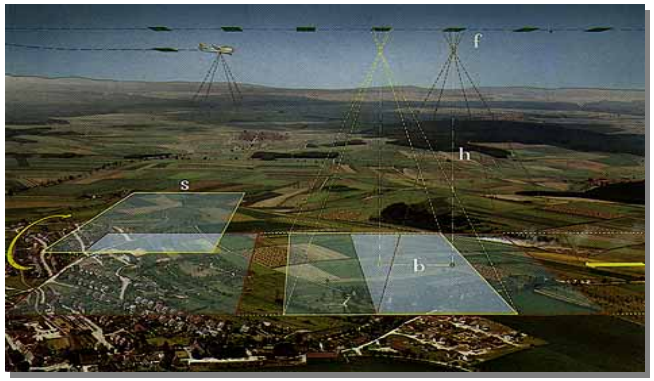
Rare Event Scenario



SVS Database Lifecycle Processes

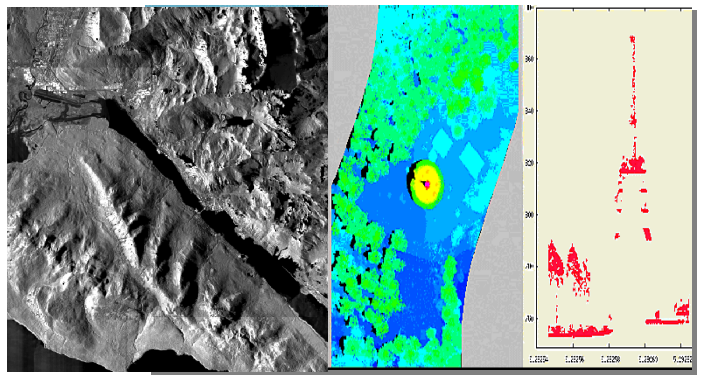
Aviation Safety Program: Synthetic Vision Systems

Data Gathering



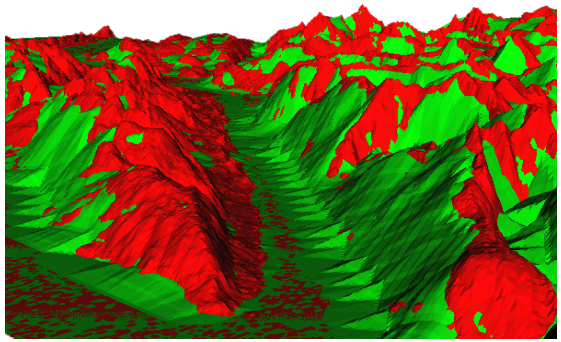
Passive Remote Sensing (Photogrammetry)

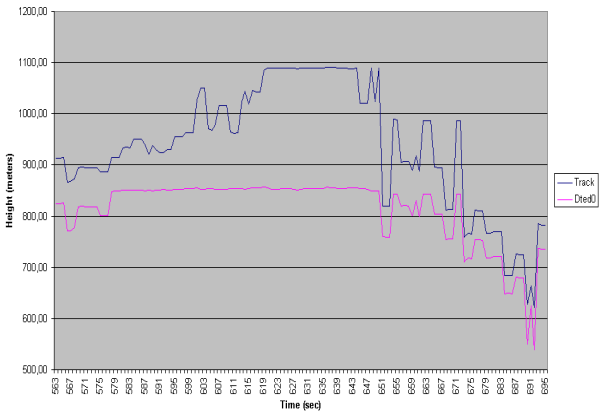
Ground Surveys



Active Remote Sensing (SAR, LIDAR)

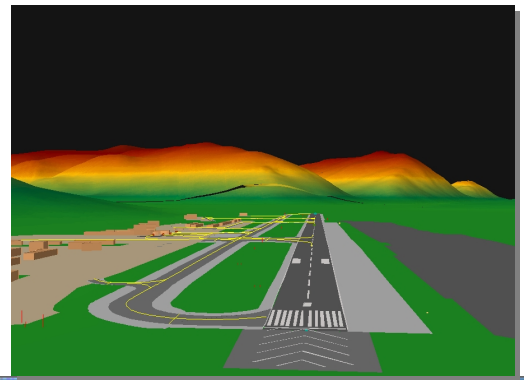
Verification & Validation





Data Gathering
↓
Data Processing
↓
V & V
↓
Database Integration
↓
Data Distribution

SVS Application

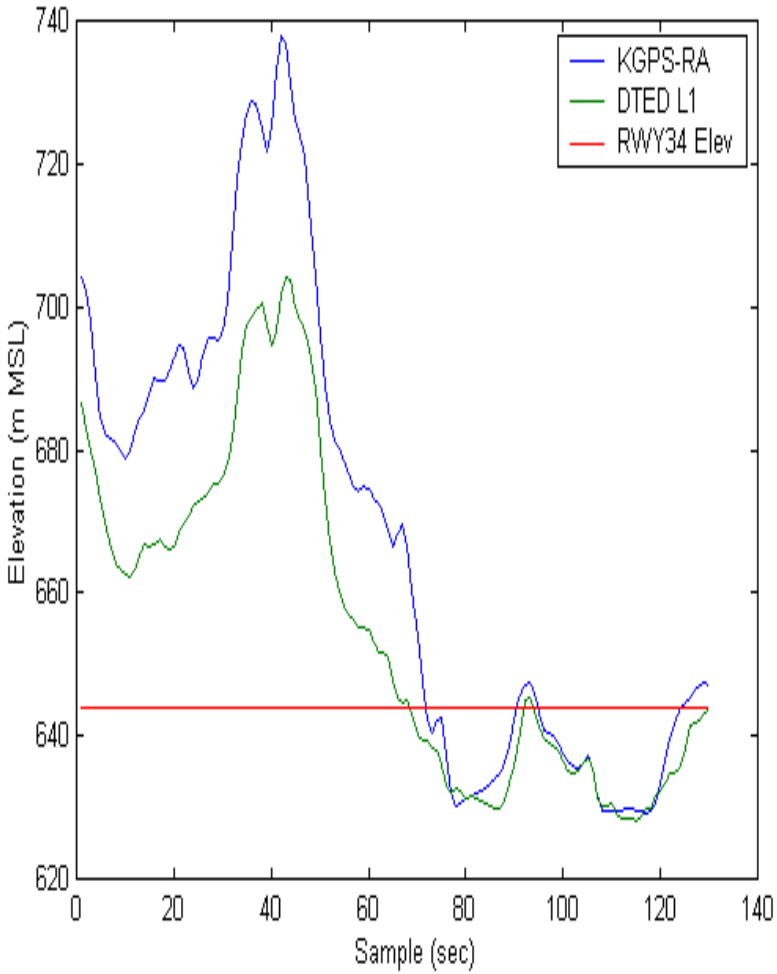


SVS Database Constraints

- Processing capability constraint
  - Moore's Law is helping
    - Started with on-board SGI Onyx systems
    - Used Pentium-3 Intergraph Zx-10 on last test
  - High end graphics cards for 3D rendering
  - 3D renderable databases are created using TerraVista
- Data source constraints
  - Resolution becoming less of a problem
  - Data Integrity is the major problem for navigation

Integrity Monitoring

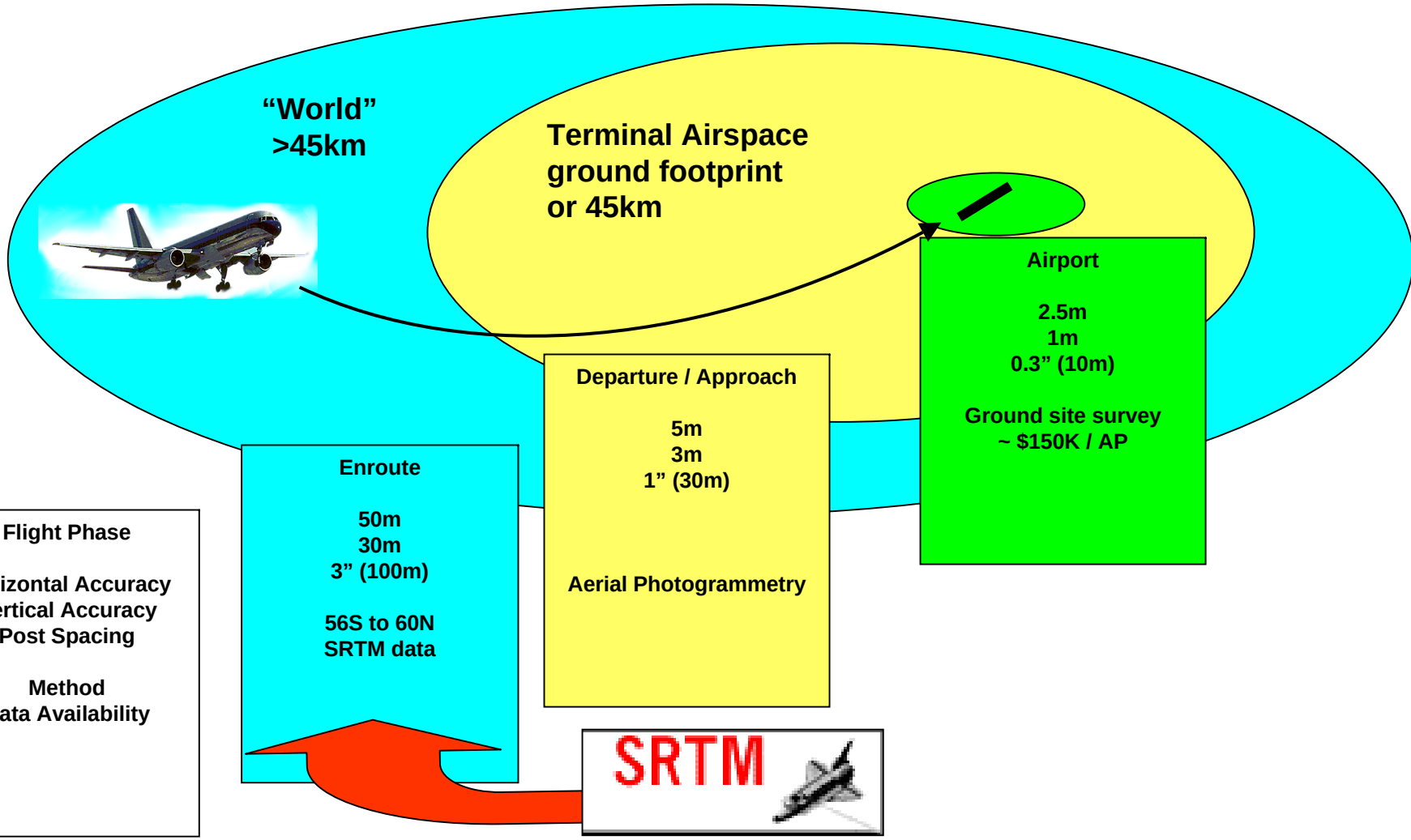
- Sensor measurements compared to database
- Issues include resolving discrepancies and updating database
- Topic of Cooperative Agreement



Shown is terrain profile during TIFS straight approach to Runway 34 at AVL (10/11/99)

SVS Conceptual Terrain Database Requirements

Aviation Safety Program: Synthetic Vision Systems



Horizontal Accuracy	20m
Vertical Accuracy	8-16m
Post Spacing	3" World 1" U.S.

Data Requirements

- Enroute requirements are met in a piecemeal manner, SRTM is a consistent 3-arcsec global dataset
- Terminal airspace data requirements can be met economically through aerial photogrammetry and IFSAR
- Airport data requirements can be met through aerial photogrammetry, LIDAR, ground survey

FAA Partnership for GA: Capstone SE Region

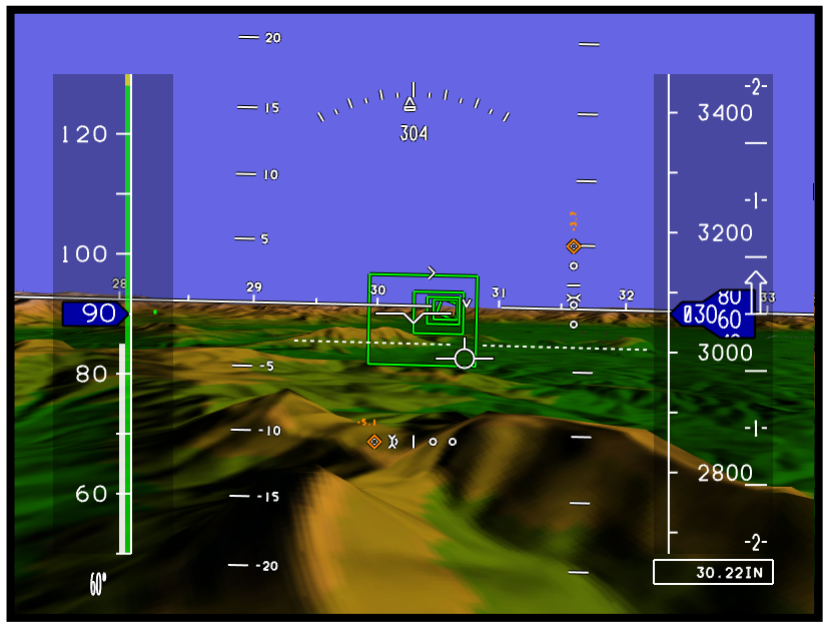
Aviation Safety Program: Synthetic Vision Systems

- NASA briefed Capstone about SVS in August 2000
- Capstone staff visited LaRC Oct 2000 to explore opportunity for collaboration

FAA Strategic Display

+

NASA Tactical Display



Enhanced Situational Awareness

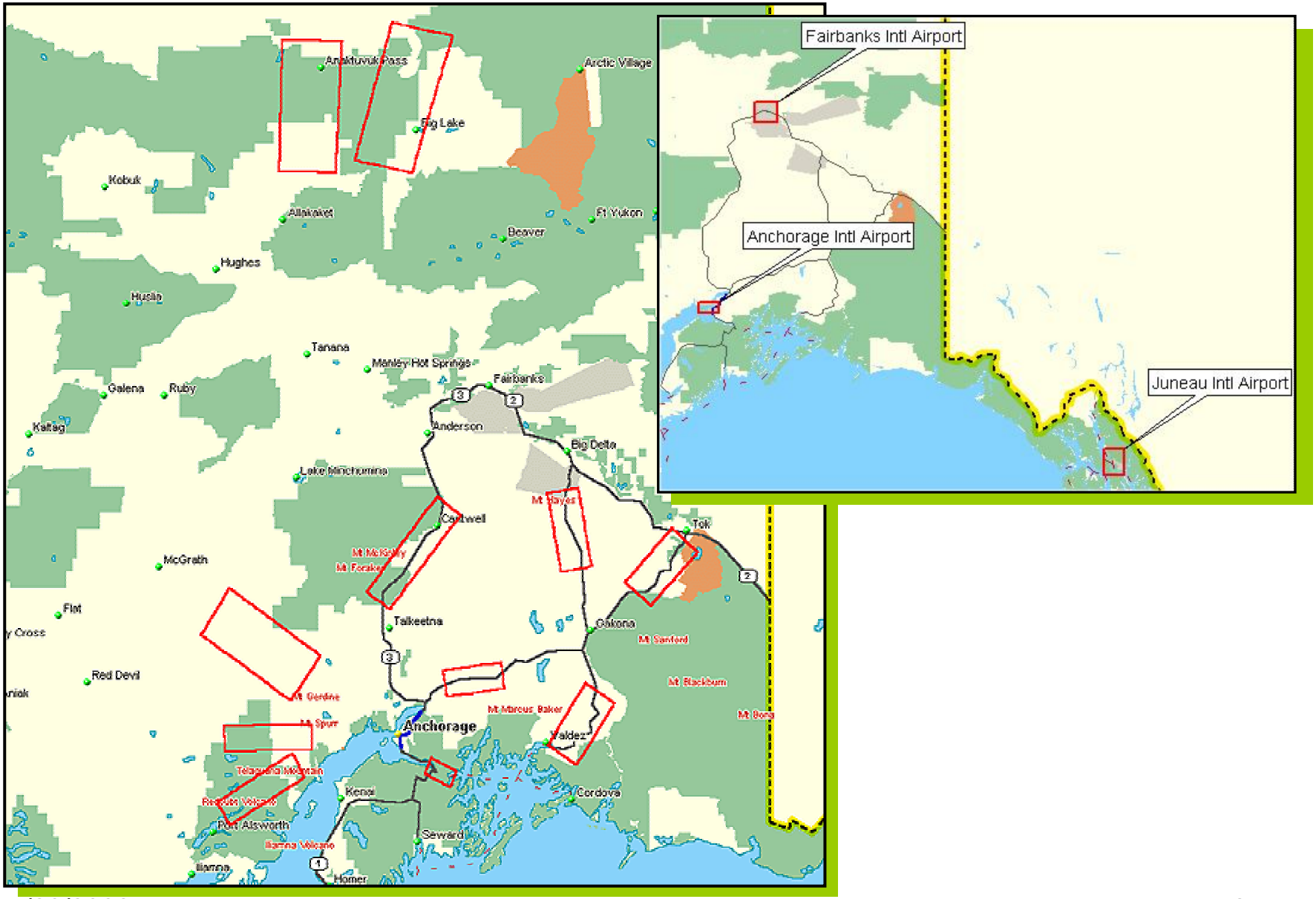
CFIT & Loss of Control Prevention

Certification: The Alaska Connection

- NASA and FAA Capstone met again at the Dec 2000 Alaska Needs Workshop to discuss NASA's role in Capstone 2
  - A synthetic vision capability was included in Capstone 2 avionics requirements
  - When SVS becomes reality in AK there will be a need for better data, especially in well traveled mountain passes
  - AK Mountain Pass CSDP task grew from this activity
    - AK SVS applications
    - Enables NASA simulator studies in terrain challenged environment

Locations Of AK Datasets

Aviation Safety Program: Synthetic Vision Systems

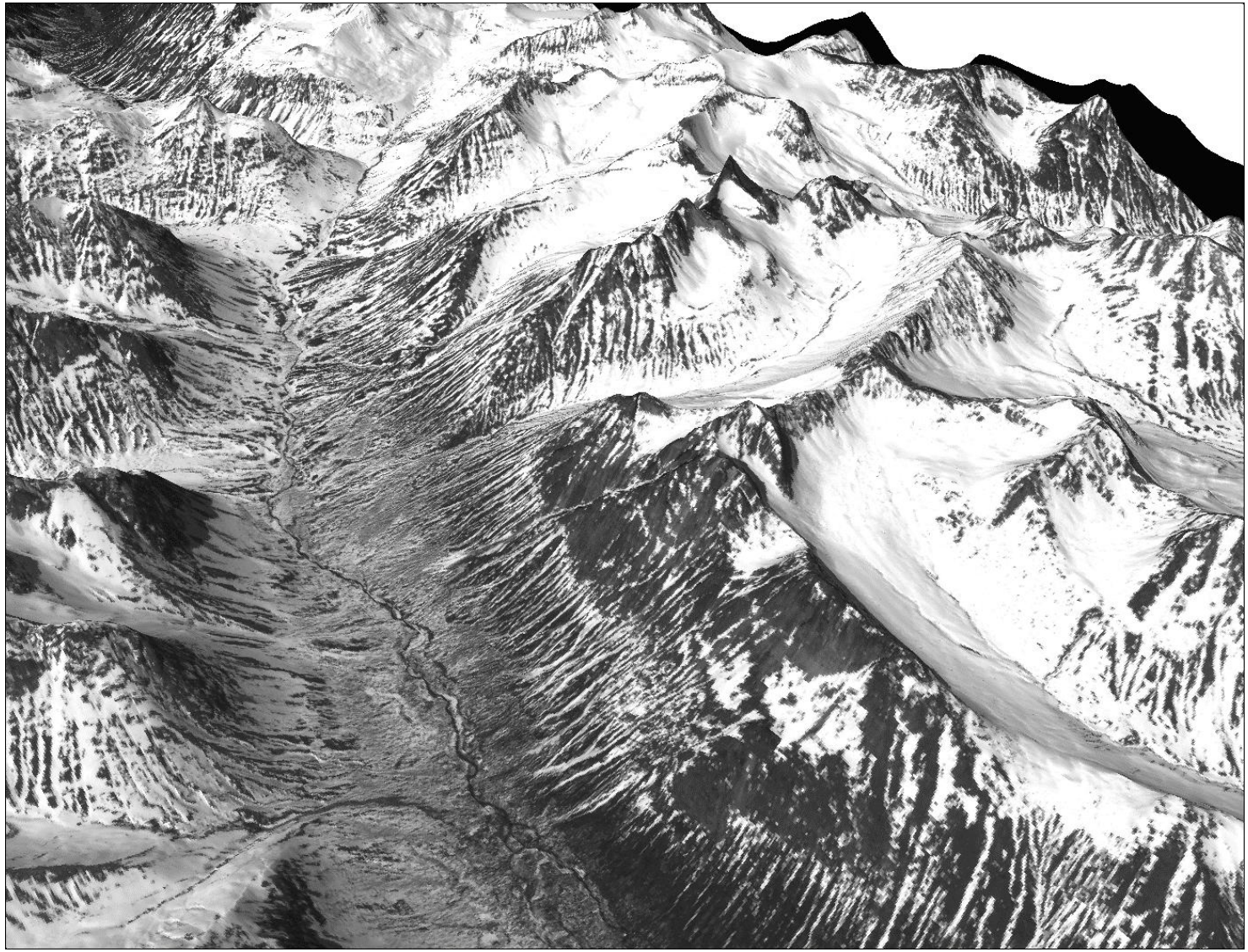


AK Department of Military and Veterans Affairs

- Search and Rescue
  - Low visibility a problem
  - Identifying current crash site
- Need SVS capabilities
  - Simulator training
  - Mission planning
  - Mission rehearsal
- Public education

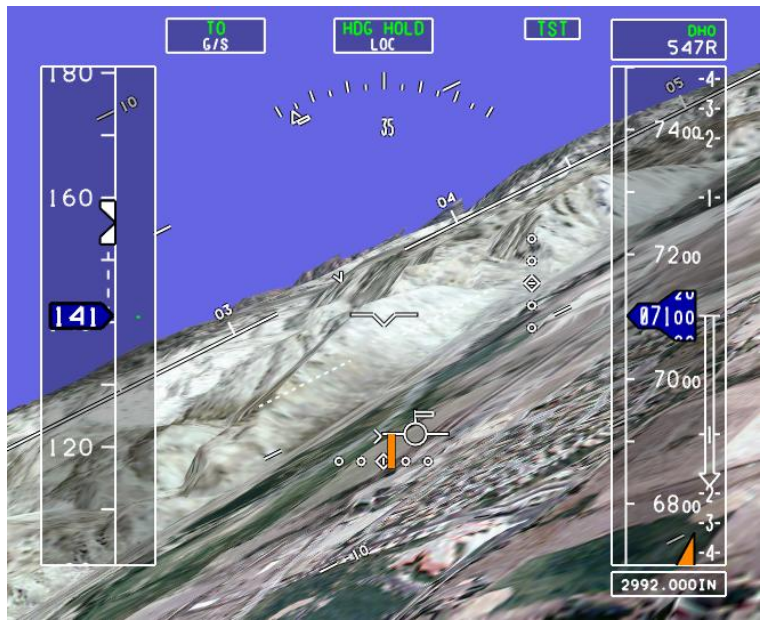
- Proposal for imagery of mountain passes made at second NASA AK Remote Sensing Data Needs Workshop (May 2001)
  - Requested imagery for mountain passes from NASA Commercial Scientific Data Purchase
    - Obtained funding for Lake Clark Pass and Merrill Pass

IKONOS Image Draped IFSAR – Merrill Pass



Synthetic Vision Systems Summary

- **NASA's Aviation Safety Program targets and eliminates fatal accident precursors**
- **SVS targets limited visibility as a causal factor to mitigate the risk of CFIT, runway incursion, & GA loss of control accidents**
- **SVS utilizes integrated high-resolution databases & integrity monitoring sensors (radar/FLIR) as required by application**
- **SVS photo-realistic concepts successfully simulated and flown at AVL, DFW, & EGE**
  - **Synthetic Vision Systems provide improved situation awareness and path control**
  - **Retrofit of Synthetic Vision into glass and non-glass cockpits is viable**
- **NASA is partnering with the DOD, FAA & Aviation Industry to save lives through SVS development & implementation**



Relevant Links

- NASA AvSP/SVS Documentation:
  http://avsp.larc.nasa.gov/images_svs.html

- FAA Capstone:
  http://www.alaska.faa.gov/capstone/