NAS Infrastructure Modernization:
A common theme to Volpe's aviation research program

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Modernized Concept for Arrivals: Continuous Descent Approach (CDA)

What is a CDA?

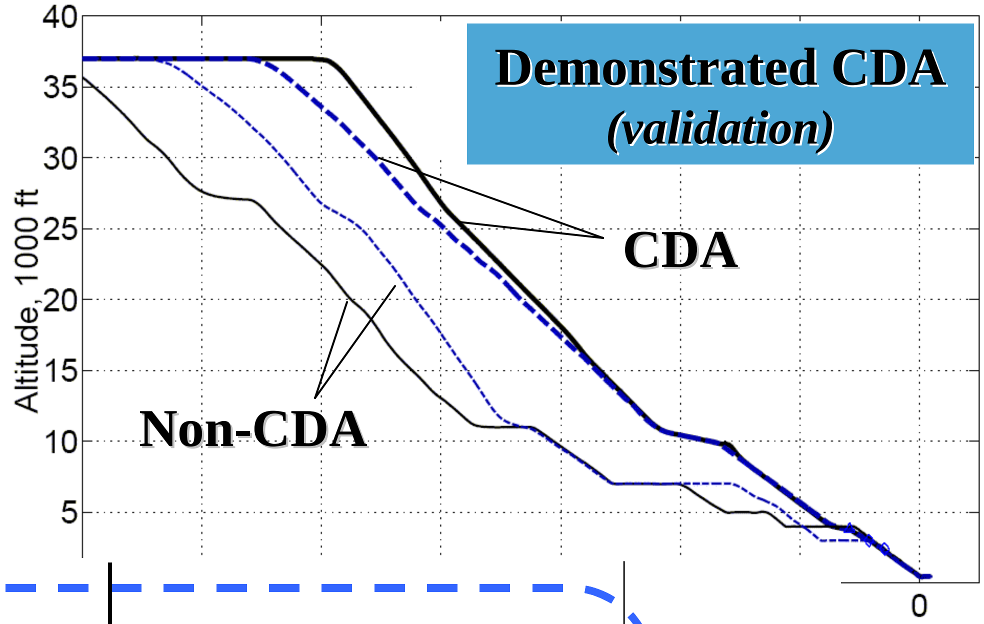
- "Minimum Thrust" approach on arrival
- Minimize/eliminate level segments on arrival
  - Reduces thrust increases
  - Reduces use of speed brakes
  - May increase altitude above population in places
    - Lower noise received on ground
    - Fewer Local Air Quality impacts

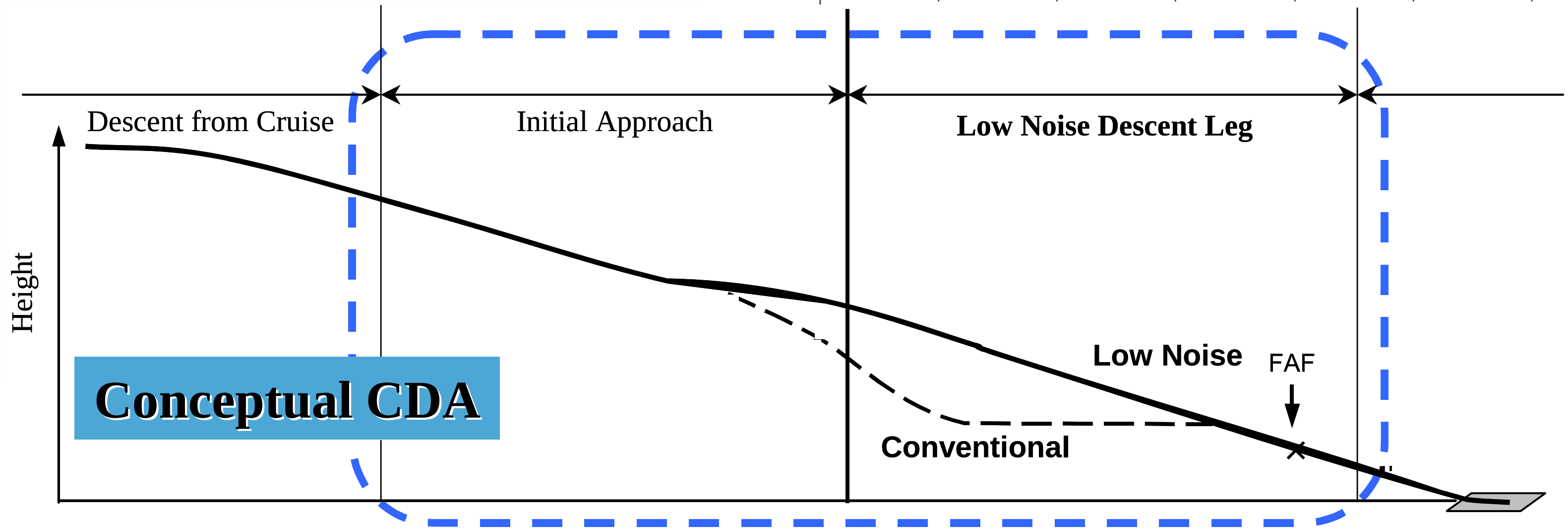
Relationship to NGATS:

- *"Create new analytical tools to understand better the relationship between noise and emissions, the different types of emissions, and the costs and benefits of different policies and actions"*

Potential CDA Benefits

- Noise
- Emissions
  - Local Air Quality
  - From Top of Descent
- Fuel burn





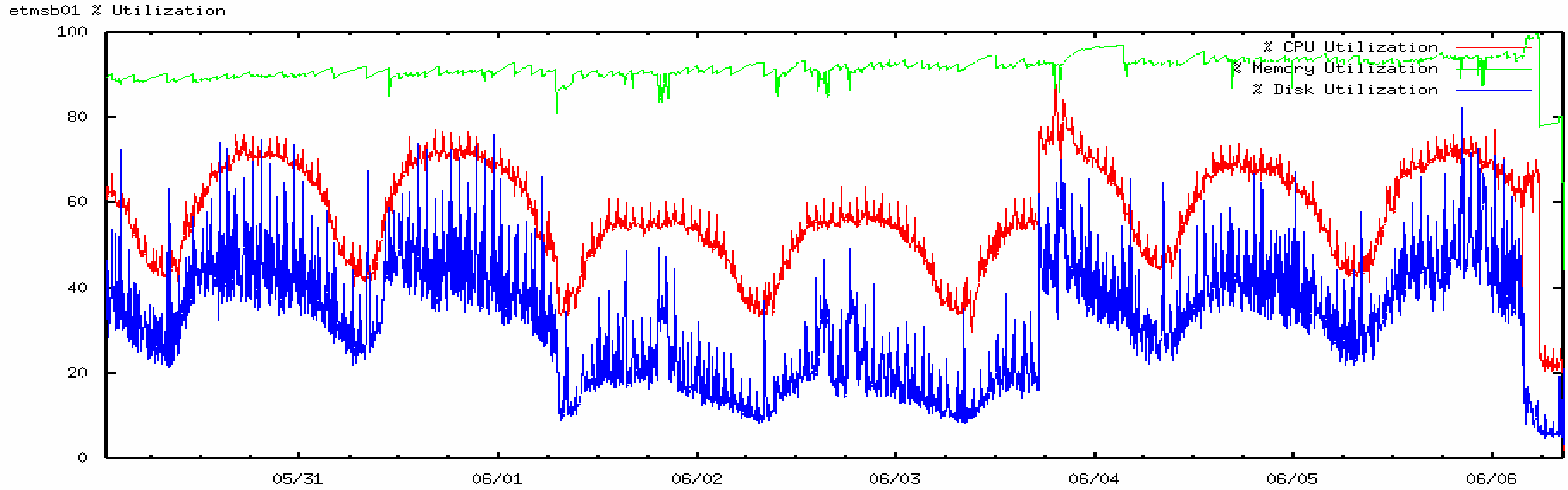
Volpe's Role on CDA

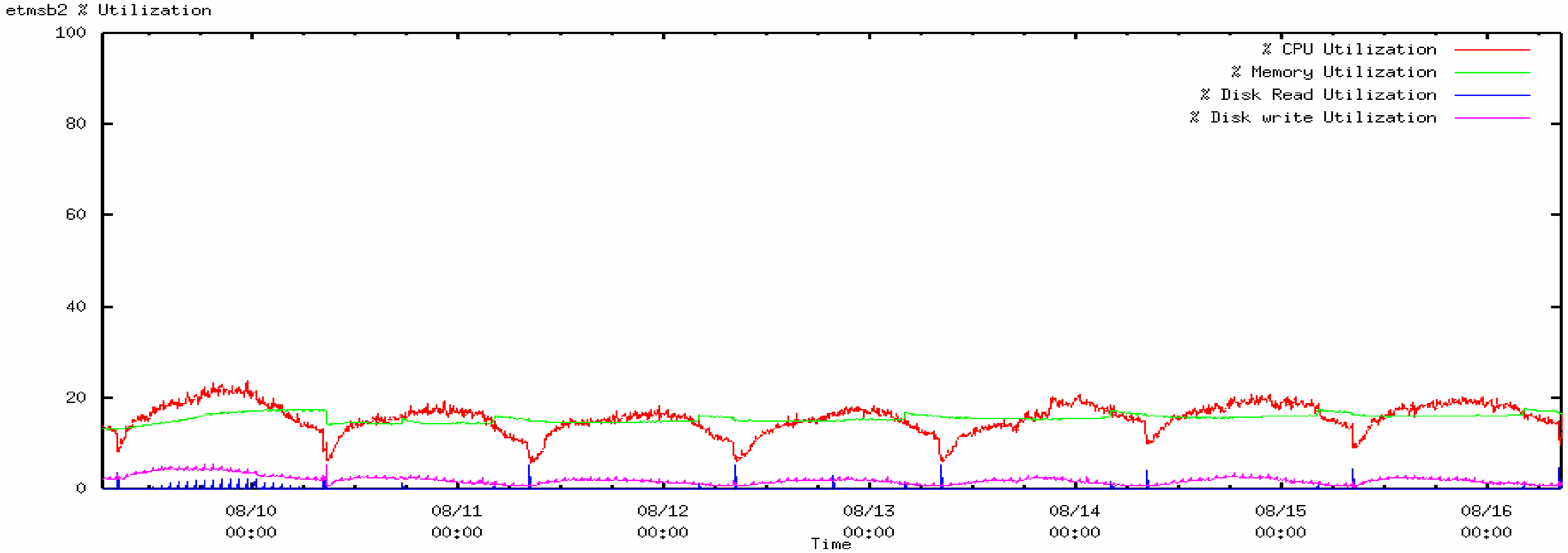
- Aviation Environmental Design Tool (AEDT) – Volpe Lead Developer
  - Development of single tool capable of analyzing both noise and emissions impacts
  - Algorithm development to understand implications of CDAs
  - Modeling demonstration analysis for ICAO Committee on Environmental Protection (CAEP)
- Coordination with FAA PARTNER Center of Excellence - Tests have shown up to:
  - 6 dBA noise reduction
  - 30 less NOx emitted
  - 500 lbs less fuel used

Goals of Traffic Flow Management (TFM) Tech Refresh

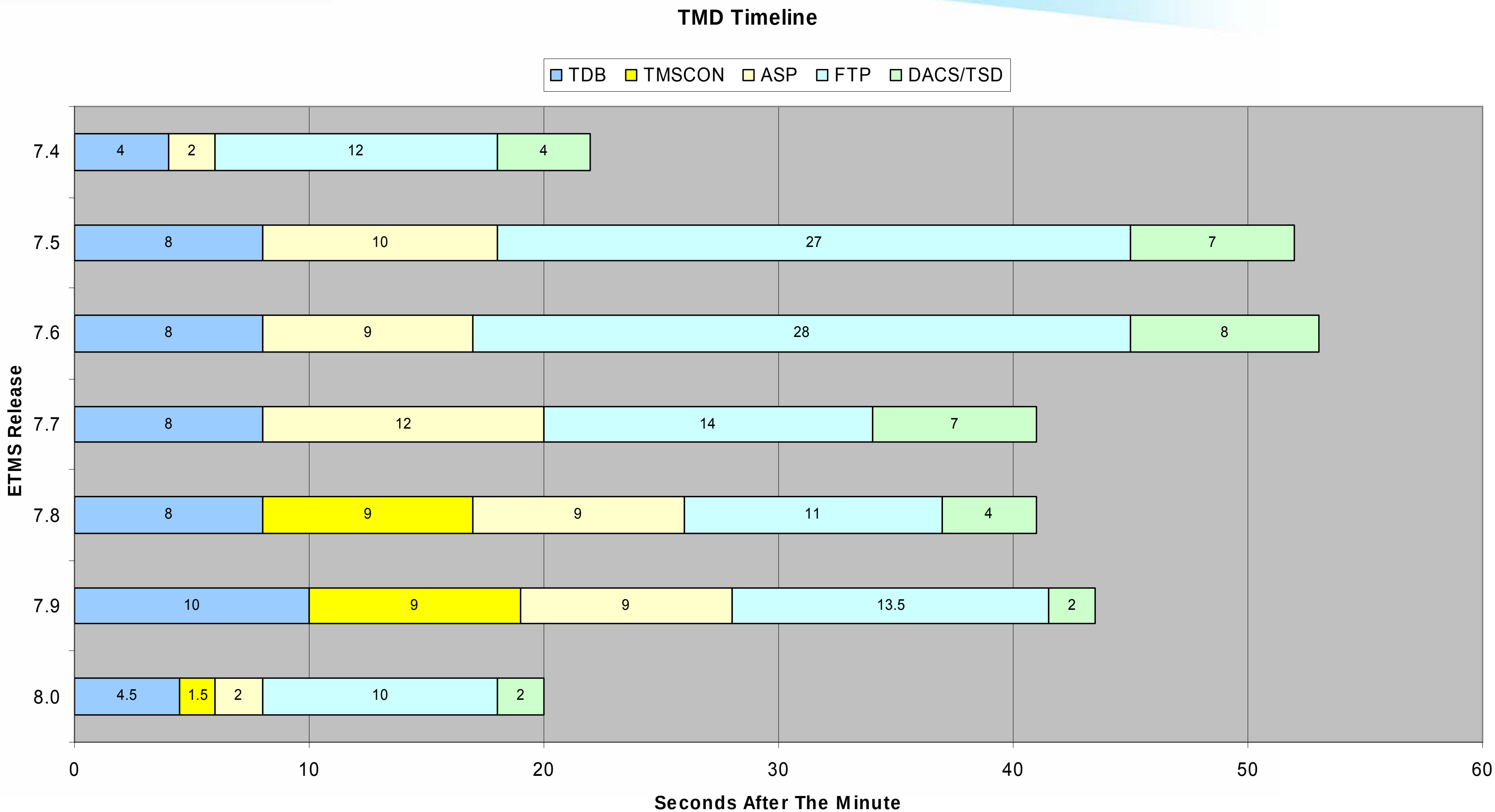
- Replace legacy Y2K infrastructure with up to date technology to reduce costs and increase functionality
- Scope: TFM Hubsite (Volpe), Disaster Recovery site (FAA Tech Center), and 80 FAA field sites.
- Timeframe: fall 2004 – spring 2005
- Results:
  - New HW and training to all sites
  - TFM HW maintenance reduced $1M/year
  - Order of magnitude improvement in HW speed
  - Linux OS replaces proprietary Unix OS
  - Noticeable application response time benefit to users
  - New functionality to reduce congestion is now achievable

TFM Hardware Utilization before and after Tech Refresh





Benefits of Tech Refresh on Monitor Alert transmission times



Enhanced FAA Safety Metrics

- Background: FAA wanted a more objective method of categorizing the severity of runway incursions.

- Volpe developed a computer model that takes into account the: conflict configuration, closest proximity between aircraft, visibility, avoidance maneuvers executed, and other factors to categorize the severity of the incursion.

Enhanced Safety Metrics - Ground

- This Runway Incursion Severity Classification (RISC) model is currently being validated by the FAA and other countries and is under consideration at ICAO as a tool for standardized ratings of runway incursions.

Runway Incursion Severity Model

From tabled worst severities S for visibility, communication and avoidance maneuver factors, given the incursion scenario and closest proximity,

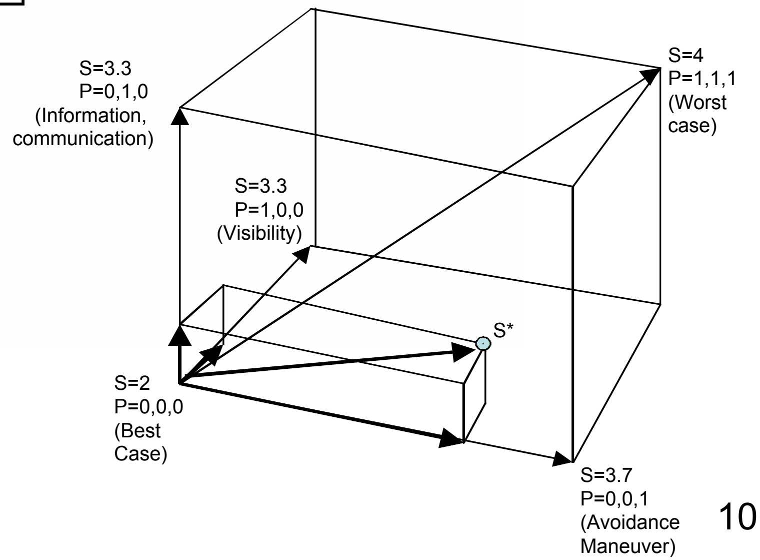
Scenaro # 48a- One takeoff aircraft					
One aircraft or vehicle enters runway with other aircraft on takeoff roll					
			ALL BEST CASE EXCEPT FOR WORST CASE OF PRIMARY FACTOR		
CLOSEST HORIZONTAL PROXIMITY	COMBINED BEST CASE	COMBINED WORST CASE	Visibility/ RVR/Ceiling	Information Comm.	Avoidance manuever
100	A =4	A =4			
500	C =2	A =4	B+ =3.3	B+ =3.3	A- =3.7
1000	D =1	B =3	C+ =2.3	C+ =2.3	B- =2.7
2500	D =1	D =1			

RVR/ VISIBILITY/ CEILING FACTOR

		CEILING			
DAY	RVR or VISIBILITY	> 1000 ft.	500 ft.	200 ft.	100 ft.
	> 3 mi.	0	1	3	10
	1 mi. = 6000 ft.	5	5	5	10
	3/4 mi. or 4500 ft.	8	8	8	10
	1/2 mi. or 3000 ft.	10	10	10	10
	1/4 mi. or 1500 ft.	10	10	10	10
NIGHT	RVR or VISIBILITY				
	> 3 mi.	3	4	5	10
	1 mi. = 6000 ft.	8	8	8	10
	3/4 mi. or 4500 ft.	10	10	10	10
	1/2 mi. or 3000 ft.	10	10	10	10
	1/4 mi. or 1500 ft.	10	10	10	10

objective data for a particular incursion event then can determine weightings P for each factor, e.g. visibility (see above right) and then a vector severity S* is determined by

$$S^* = S_b + P_1(S_1 - S_b) + \left[\Sigma_{i=2 \text{ to } N} P_i^2 (S_i - 1)^2 / \Sigma_{i=2 \text{ to } N} (S_i - 1)^2\right]^{0.5} (S_w - S_1)$$



Severity of Wake Vortex Encounter

Leading a/c	LARGE			Following aircraft: HEAVY								B757						LARGE						SMALL			
Trailing a/c	SMALL																										
h-separation	4	Leading	h (ft.) below	Estimated separation, nr						Estimated separation, n						Estimated separation, n						Estimated separation, nm					
v-separation	400	aircraft	glideslope	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
			0	A	B	C	C	C	C	A	B	C	C	C	C	A	B	C	C	C	C	A	B	C	C	C	C
List of sizes:		HEAVY	50	A	A	B	C	C	C	A	A	B	C	C	C	A	A	B	C	C	C	A	A	B	C	C	C
HEAVY			100	A	A	B	C	C	C	A	A	B	C	C	C	A	A	A	B	C	C	A	A	A	A	B	C
B757			200	A	A	B	C	C	C	A	A	B	C	C	C	A	A	A	B	C	C	A	A	A	A	B	C
LARGE			300	A	A	B	C	C	C	A	A	B	C	C	C	A	A	A	B	C	C	A	A	A	A	B	C
SMALL			400	A	A	B	C	C	C	A	A	B	C	C	C	A	A	A	B	C	C	A	A	A	A	B	C
			500		A	B	C	C	C		A	B	C	C	C		A	A	B	C	C		A	A	A	B	C
column	4		600			B	C	C	C			B	C	C	C			A	B	C	C			A	A	B	C
row	6		700			B	C	C	C			B	C	C	C			A	B	C	C			A	A	B	C
			800				C	C	C				C	C	C				B	C	C				A	B	C
table	LARGE-SMALL		900					C	C					C	C					C	C					B	C
			1000						C						C						C						C
Lead HEAVY	NA		0	A	B	C	C	C	C	A	B	C	C	C	C	A	B	C	C	C	C	A	B	C	C	C	
Lead B757	NA	B757	50	A	A	B	C	C	C	A	A	B	C	C	C	A	A	B	C	C	C	A	A	B	C	C	C
Lead LARGE	C		100	A	A	B	C	C	C	A	A	B	C	C	C	A	A	B	C	C	C	A	A	A	B	C	C
			200	A	A	B	C	C	C	A	A	B	C	C	C	A	A	B	C	C	C	A	A	A	B	C	C
Severity	C		300	A	A	B	C	C	C	A	A	B	C	C	C	A	A	B	C	C	C	A	A	A	B	C	C
			400	A	A	B	C	C	C	A	A	B	C	C	C	A	A	B	C	C	C	A	A	A	B	C	C
			500		A	B	C	C	C		A	B	C	C	C		A	B	C	C	C		A	A	B	C	C
			600			B	C	C	C			B	C	C	C			B	C	C	C			A	B	C	C
			700			B	C	C	C			B	C	C	C			B	C	C	C			A	B	C	C
			800				C	C	C				C	C	C				C	C	C				B	C	C
			900					C	C					C	C					C	C					C	C
			1000						C						C						C						C
			0													A	B	C	C	C	C	A	B	C	C	C	C
		LARGE	50													A	B	C	C	C	C	A	A	B	C	C	C
			100													A	B	C	C	C	C	A	A	B	C	C	C
			200													A	B	C	C	C	C	A	A	B	C	C	C
			300													A	B	C	C	C	C	A	A	B	C	C	C
			400														B	C	C	C	C		A	B	C	C	C
			500														B	C	C	C	C		A	B	C	C	C
			600															C	C	C	C			B	C	C	C
			700																C	C	C				C	C	C
			800																	C	C					C	C
			900																		C						C
			1000																								

Enhanced Safety Metrics – Radar Environments

- Volpe is now developing metrics to categorize the severity of losses of standard separation in the radar environments (ARTCC and TRACON). Metrics are being designed to reflect the: proximity to collision, degree of the loss of required separation, severity of the operational error that resulted in the loss of standard separation.

Airport Surface Detection Equipment (ASDE-X)

- New-generation airport surface surveillance system
- Two sensor subsystems
  - Primary radar
  - Beacon multilateration
- Volpe evaluated low-cost candidate
  - Automatic detection, high resolution surveillance of airport movement areas, approach corridors, other areas of interest
  - Extracted radar plot data and processed digital video
- FAA conducted competitive acquisition
- Volpe supporting deployment
  - Installation and test
  - Ad hoc problem solutions
  - RF Modem development

ELAR Radar at Salt Lake City

Dassault Radar at Norfolk

ASDE-X System Production Equipment

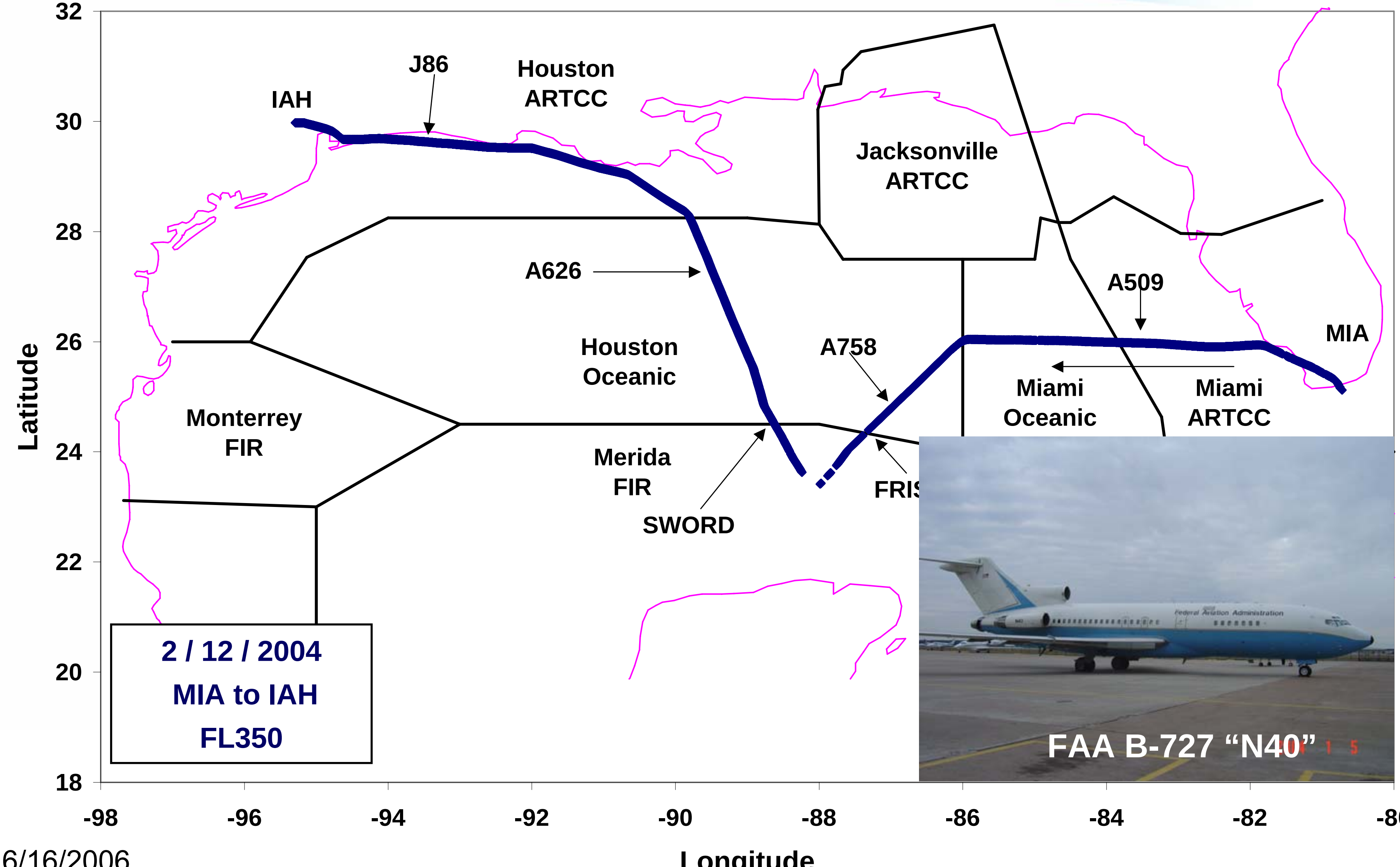
Surface Movement Radar

Multilateration Equipment

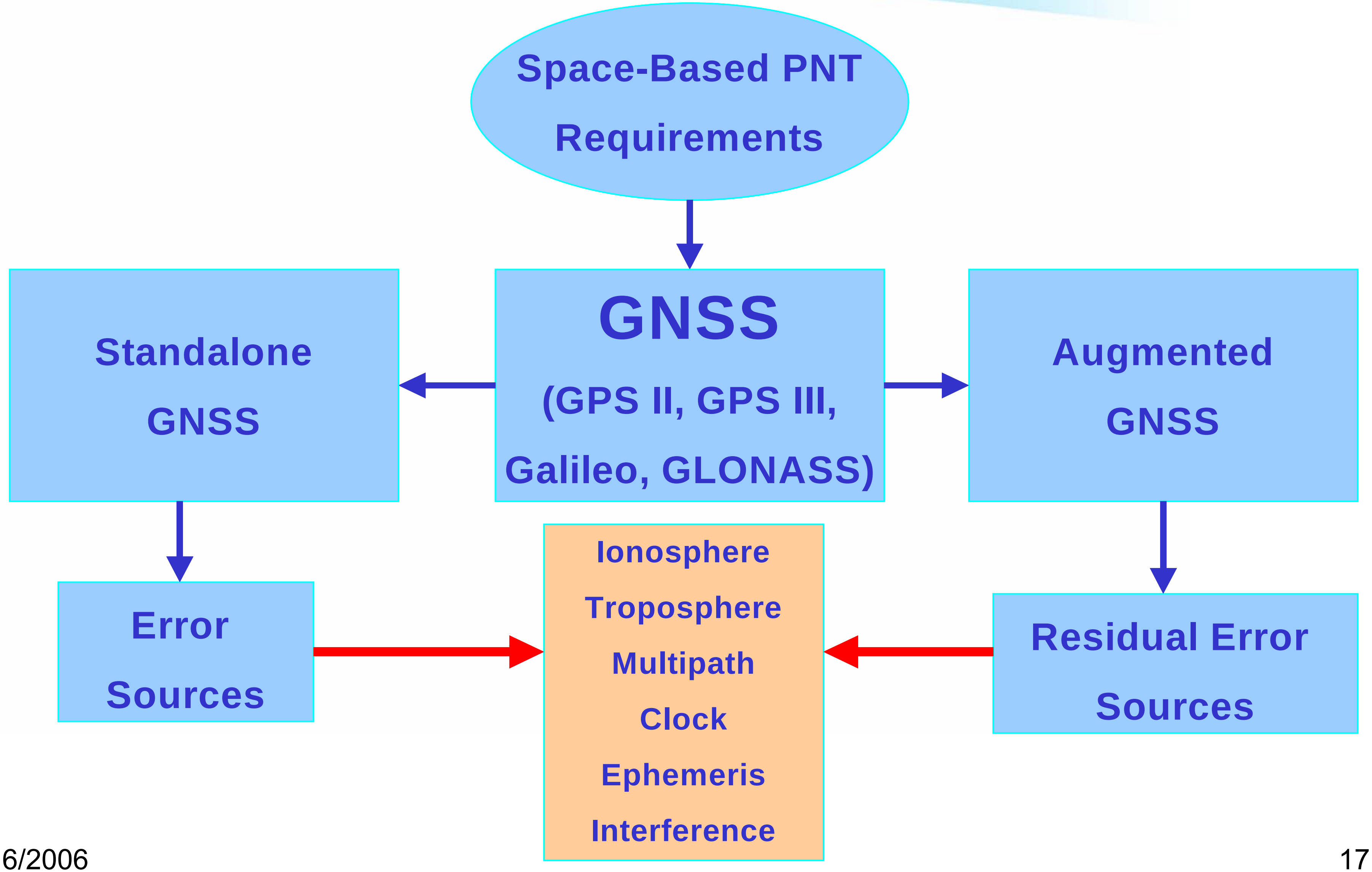
Gulf of Mexico Evaluation of ADS-B and Multilateration

- Sponsors:
  - **NASA — Original sponsor**
  - **FAA — Program participant**
- Problems
  - **No radar coverage across Gulf**
  - **No coverage of offshore aircraft**
- Two Candidate Solutions
- ADS-B
  - **New transponders**
  - **One ground station in view**
- Wide Area Multilateration
  - **Current transponders**
  - **Multiple ground stations in view**
- Three-phase / four-year effort
  - **Standard terminal area**
  - **Small terminal area (helo-focus)**
  - **En Route / Oceanic**

Experimental ADS-B Track Gulf of Mexico

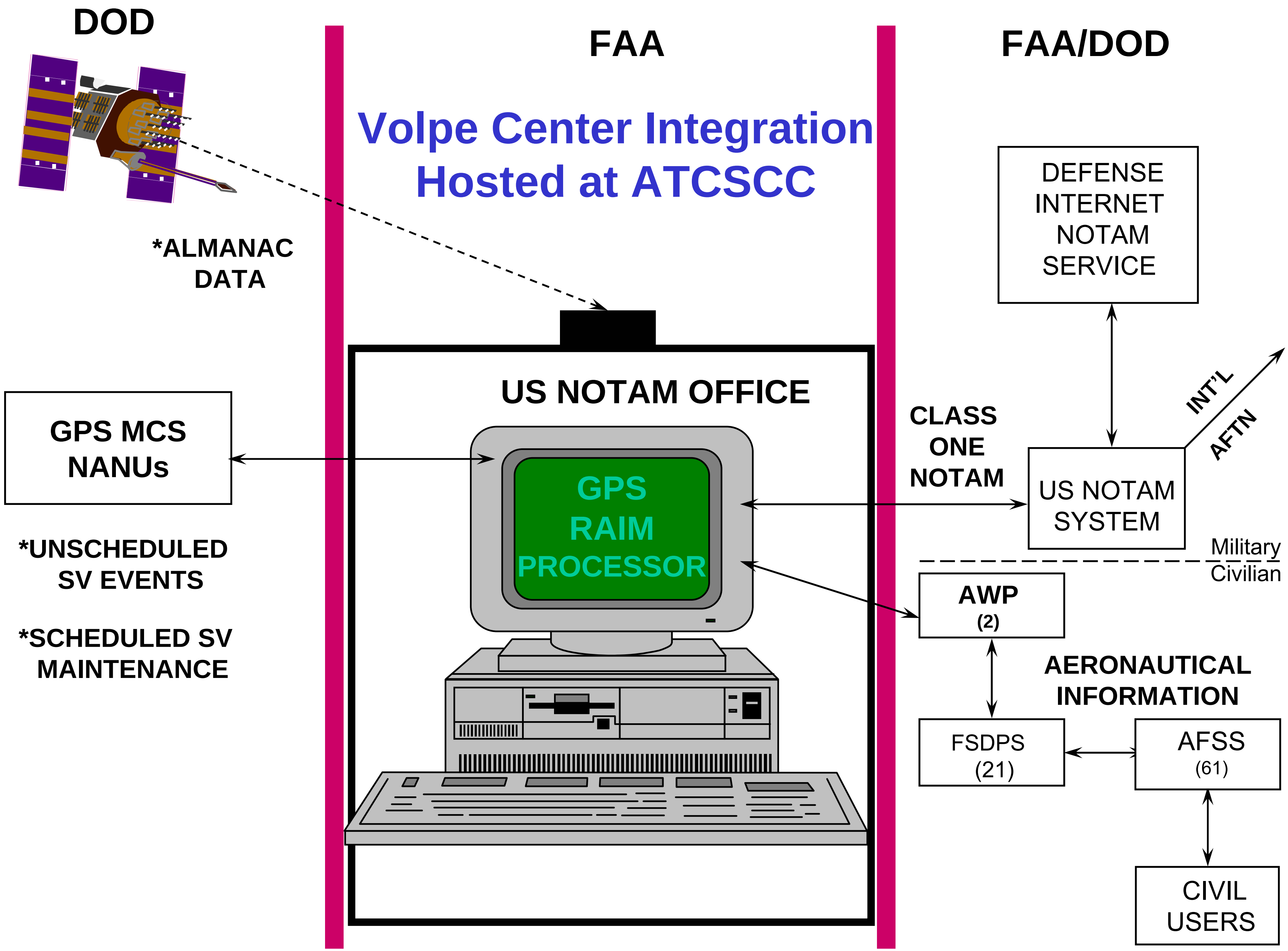


Focus of Space-Based PNT Research and Applications

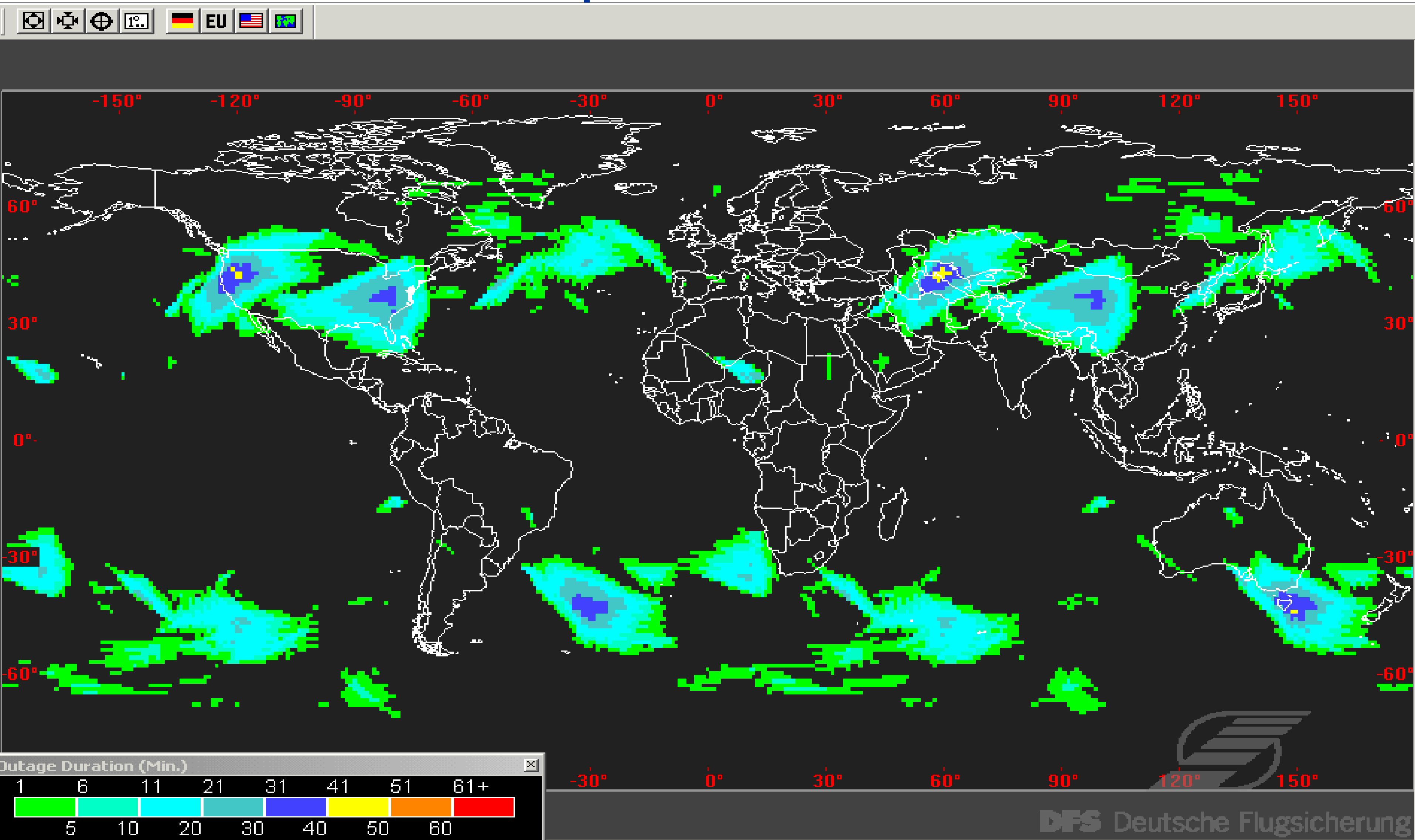


GNSS Impact on CNS/ATM

- GNSS is Different From Ground Based Navaids
- Areas of Degraded Coverage Not Stationary due to Motion of Satellite Tracks
- Pilots/ATC Need to Know Where and When GNSS is Not Available
- Vulnerabilities of GNSS Must be Addressed


DOD
FAA
FAA/DOD
Volpe Center Integration
Hosted at ATCSCC
*ALMANAC DATA
DEFENSE INTERNET NOTAM SERVICE
US NOTAM OFFICE
GPS MCS NANUs
GPS RAIM PROCESSOR
CLASS ONE NOTAM
US NOTAM SYSTEM
INT'L
AFTN
Military
Civilian
*UNSCHEDULED SV EVENTS
*SCHEDULED SV MAINTENANCE
AWP (2)
AERONAUTICAL INFORMATION
FSDPS (21)
AFSS (61)
CIVIL USERS

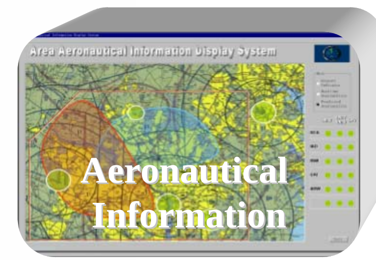
TSO C129 RAIM NPA Availability PRN 5 Out of Service September 2005 Volpe Center Model



Brazil GPS Performance Monitoring System Overview

Monitor

Output



Monitoring
CGNA/ACC/APP

Wake Vortex Program Goals

- Increase airport arrival and departure rates by reducing wake-imposed aircraft separations
- Increase safety margin by employing new procedures only under specific conditions

Part of Volpe Instrumentation at St. Louis Airport

Wake RMP Sequence of Mitigation Changes

1. Procedure changes only (weather independent)
2. Changes based on data from existing airport weather sensors
   - Primarily wind
3. Changes based on new weather sensors
   - Wind — vertically and horizontally dispersed
   - Wake demise
4. New procedures using data from newly-procured wake sensors

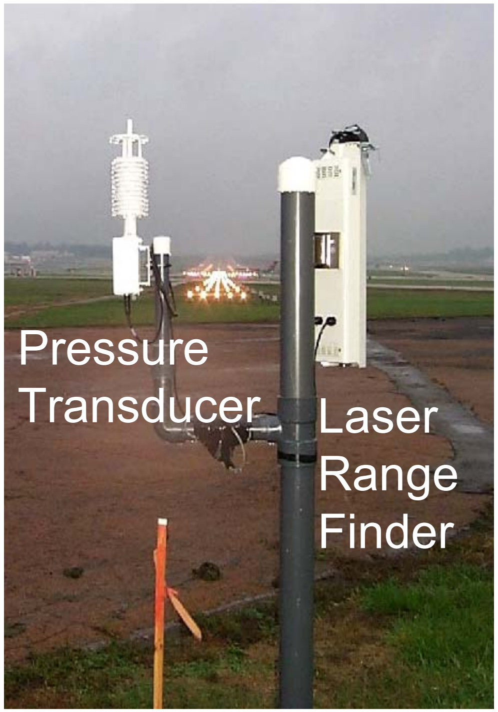
Current Volpe Activities

- Experimental data collection and analysis for procedure and safety case development
  - St. Louis (on-going)
    - Waiver to 2500-ft rule (procedural change)
    - Change to Order 7110.65 to 2500-ft rule (procedural change)
    - Preparing for departure measurements
  - Denver (on-going)
    - Support to STL work
    - Experimental sensor evaluation
  - Planning for additional airports
    - San Francisco
    - Cleveland
    - Memphis
    - Houston
- Contributing to
  - ConOps development
  - A380 Issue
  - B757 Classification Issue
- Wake sensor development

Pulsed Lidar at St. Louis Airport

STL Sensors

Largest Wake Data Collection Effort to Date



Aircraft Detectors (2)

Windline (2)

Sodar (3)

Data Bases

- TAMIS
- ASDE-X
- ASOS
- LLWAS

Pulsed Lidar (3)