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

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Volpe National Transportation Systems Center
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

Diagram:
- Descent from Cruise
- Initial Approach
- Low Noise Descent Leg
- Non-CDA
- CDA
- Demonstrated CDA (validation)

Conceptual CDA
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 Hubsites (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
Benefits of Tech Refresh on Monitor Alert transmission times

TMD Timeline

<table>
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<tr>
<th>ETMS Release</th>
<th>TDB</th>
<th>TMSCON</th>
<th>ASP</th>
<th>FTP</th>
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Seconds After The Minute
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,

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

$$S^* = S_b + P_1(S_1-S_b)$$

$$+ \left[ \sum_{i=2}^{N} P_i (S_i-1)^2 / \sum_{i=2}^{N} (S_i-1)^2 \right]^{0.5} (S_w-S_1)$$

<table>
<thead>
<tr>
<th>Scenario # 48a- One takeoff aircraft</th>
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<th>ALL BEST CASE EXCEPT FOR WORST CASE OF PRIMARY FACTOR</th>
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<tr>
<td>One aircraft or vehicle enters runway with other aircraft on takeoff roll</td>
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<td><strong>CLOSEST</strong></td>
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<td><strong>COMBINED</strong></td>
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| | **RVR/ VISIBILITY/ CEILING FACTOR** | |
| | **DAY** | **CEILING** | **> 1000 ft.** | **500 ft.** | **200 ft.** | **100 ft.** |
| | | **RVR or VISIBILITY** | **> 3 mi.** | **1 mi. = 6000 ft.** | **3/4 mi. or 4500 ft.** | **1/2 mi. or 3000 ft.** | **1/4 mi. or 1500 ft.** |
| | | | | 5 | 5 | 5 | 10 |
| | | | | 8 | 8 | 8 | 10 |
| | | | | 10 | 10 | 10 | 10 |
| | | | | 10 | 10 | 10 | 10 |
| | **NIGHT** | **RVR or VISIBILITY** | | 3 | 4 | 5 | 10 |
| | | | | 8 | 8 | 8 | 10 |
| | | | | 10 | 10 | 10 | 10 |
| | | | | 10 | 10 | 10 | 10 |
| | | | | 10 | 10 | 10 | 10 |
## Severity of Wake Vortex Encounter

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<th>Following aircraft: HEAVY</th>
<th>B757</th>
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<td>v-separation</td>
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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
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

- Monterey FIR
- Houston ARTCC
- Merida FIR
- SWORD
- Jacksonville ARTCC
- Miami Oceanic
- Miami ARTCC

2 / 12 / 2004
MIA to IAH
FL350

FAA B-727 “N40”
Focus of Space-Based PNT Research and Applications

Space-Based PNT Requirements

- Standalone GNSS
- GNSS (GPS II, GPS III, Galileo, GLONASS)
- Augmented GNSS

Error Sources
- Ionosphere
- Troposphere
- Multipath
- Clock
- Ephemeris
- Interference

Residual Error Sources
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
Volpe Center Integration
Hosted at ATCSCC

US NOTAM OFFICE

GPS RAIM PROCESSOR

*ALMANAC DATA

GPS MCS
NANUs

*UNSCHEDULED
SV EVENTS

*SCHEDULED SV
MAINTENANCE

FAA

FAA/DOD

DEFENSE
INTERNET
NOTAM
SERVICE

CLASS
ONE
NOTAM

US NOTAM
SYSTEM

AWP
(2)

AERONAUTICAL
INFORMATION

FSDPS
(21)

AFSS
(61)

CIVIL
USERS

Military
Civilian

INT’L
AFTN

Volpe Center Integration
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(61)

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Civilian

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AFTN
TSO C129 RAIM NPA Availability
PRN 5 Out of Service September 2005
Volpe Center Model
Brazil GPS Performance Monitoring System Overview

Monitor

Output

GPMS Processing

Web Access

Aeronautical Information

Monitoring CGNA/ACC/APP

GEO

DECEA

Porto Alegre

Manaus

Recife

Brasilia

Rio de Janeiro

DECEA

GEO

GRTM

Brazil TRS

Brazil TMS

Brazil GPS Performance Monitoring System Overview
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

Data Bases
- TAMIS
- ASDE-X
- ASOS
- LLWAS

- Aircraft Detectors (2)
- Pressure Transducer
- Laser Range Finder
- Sodar (3)
- Windline (2)
- Pulsed Lidar (3)