4.2 Integrating Advanced Airspace System Components in a NAS-Wide Simulation

Integrating Advanced Airspace System Components in a NAS-Wide Simulation

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Agenda

- Organization and programs supported
- NAS-wide simulation for systems analysis
- ACES simulation quick overview
- Enhancements for new capabilities
- Demonstration videos
- Future research possibilities
Organization

• Aeronautics Systems Analysis Branch (ASAB), NASA Langley Research Center

• Aircraft and airspace system concept analysis
  – Both customer supplied and internally defined
  – Identification of promising new technologies
  – Support agency’s strategic research planning
  – Support competitive aerospace proposal generation and evaluation
  – Use and advance an integrated suite of tools to conduct this analysis

ASAB Support for NextGen

• NextGen time frames
  – Near-term – by 2012
  – Mid-term – by 2018
  – Final capabilities - post 2025

• ASAB supports far-term goals
  – Assumes advanced airspace management tools
  – Highly automated decision making

• Research areas
  – Demand/capacity/constraint analysis
  – Metroplex operations
NAS-Wide Simulations

- Systems Analysis for NextGen requires capability to model at National Airspace System (NAS) level
- Focuses on overall benefits, rather than individual components and capabilities of a particular aircraft
- Large number of flights modeled
  - FAA Terminal Area Forecast (TAF) report:
    - 30000 flights/day (current day avg, cont. US, commercial)
    - > 40000 flights/day - projected for 2030

NAS-Wide Simulations

- NASPAC (FAA)
  “National Airspace System Performance Capability”
- SIMMOD (FAA)
- PNP (Sensis)
  “Probabilistic NAS Platform”
- RAMS – Eurocontrol Experimental Center
  “Reorganized ATC Mathematical Simulator”
- TAAM (MITRE)
  “Total Airport and Airspace Model”
- ACES (NASA Ames)
  “Airspace Concepts Evaluation System”
  - Open source
ACES Simulation Overview

- Developed to assess system-wide impacts of airspace technologies and operational concepts
- Agent-based simulation
  - Event-driven components
  - Time-driven components (event = time step)
- Provides modeling of current day NAS
- Extensible (via “plugins”) framework

ACES Capabilities

- Uses Cybele (IAI) as core executive
- Agents in ACES map to real world entities in the National Airspace System (NAS)
  - Flights
  - Airports
  - TRACON ATC
  - En-route ATC
  - Surveillance
  - Physical layout of airspace (sectors, centers)
ACES Overview

ACES Visualization


ACES Demonstration

(Video of ACES visualization window running a typical simulation scenario with midday traffic volume)

ACES Viewer

- ACES support tool for post-run visualization
- Runs using IV4D
  - Built for Air Force Research Labs by Aerospace Computing, Inc (ACI)
- Visualizes anything with lat/long/alt/time points
- Extended to support ACES output style
ACES Viewer Demo

Video of previous ACES demo video, now run in ACES Viewer with 3-D view rotated and manipulated

ACES Enhancements

• ACES provides a powerful framework, but must be extended for new concept testing
  – Merging and Spacing (M&S) in the airport vicinity
  – Conflict Detection and Resolution (CD&R)
    • Tactical
      – State-based
      – Prevent impending (< 2 minute) loss of separation (LOS)
    • Strategic
      – Intent-based
      – Prevent future (10-20 minutes out) LOS event

• Default ACES cannot support this type of study
ACES Capabilities

- CD&R in ACES
  - Tactical only
  - Based on NAS Center boundaries
  - Very limited capability

ACES Capabilities

- No M&S in ACES
  - Default TG is MPAST
  - MPAST does not model trajectory between arrival/departure fix and airport
    (Node/Queuing model)
ACES Enhancements

- NASA Langley contracted software development for prototype
- Intelligent Automation, Inc. (IAI)
  - ACES development team member
  - M&S concept developed in previous initiative
  - CD&R (tactical) developed in previous initiative
- Expanded CD&R
  - ACCoRD (tactical) – NASA LaRC, NIA
  - Stratway (intent) – NASA LaRC
- M&S
  - Refinement of IAI concept design
  - Multi-Point Scheduling Algorithm – NASA ARC

Current Status – M&S

- Two airports with detailed databases
  - Atlanta Hartsfield (KATL)
  - Dallas/Fort Worth (KDFW)
- M&S development complete
- Testing mostly complete
- Demonstration of full system in progress
Current Status – M&S

Video of ACES simulation run with M&S running traffic to KATL

Current Status – CD&R

• Implementation complete for tactical and strategic CD&R
• Work on-going with CD&R Stratway and ACCoRD team to provide feedback for continued tool development
• Integration with M&S completed
• Testing mostly complete
• Demonstration of full system (M&S with CD&R) in development
Current Status - CD&R

Video of ACES simulation running with strategic CD&R enhancements

Future Research Possibilities

• Quantification of airport throughput as a function of aircraft spacing (R. Brown, 2010)
• Arrival routing concept development to improve airport throughput
• Effect of CD&R maneuver strategies on system delay and fuel efficiency
• Impact of CD&R on M&S efficiency and robustness
Questions/Discussion

Backup Slides
### FAA’s Terminal Area Forecast, 2010, page 18:

#### 2008 (last historic data available)

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<tr>
<th>Category</th>
<th>Estimation</th>
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<tr>
<td>Yearly National Total Commercial (takeoffs and landings) (includes Alaska and West Indies)</td>
<td>27,951,930</td>
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<td>Yearly Alaska</td>
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<td>Yearly Western Pacific</td>
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<td>Yearly Continental US (takeoffs and landings)</td>
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<td>Daily Flights (yearly operations/2 ops per flight/365 days)</td>
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#### 2030 (Projected Data)

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<th>Estimation</th>
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<tr>
<td>Daily Flights ((366,462,488 NT – 105,904,6 AK – 611,357,9 WP)/365/2)</td>
<td>40,375</td>
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