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

Integrating Advanced Airspace System Components in a NAS-Wide Simulation

Patricia Glaab
NASA Langley Research Center

October 14, 2010

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)**
- Yearly National Total Commercial (takeoffs and landings): 27951930
  (includes Alaska and West Indies)
- Yearly Alaska: -937116
- Yearly Western Pacific: -4899428
- Yearly Continental US (takeoffs and landings): 22115386
- Daily Flights (yearly operations/2 ops per flight/365 days): 30295

**2030 (Projected Data)**
- Daily Flights ((36646248 NT – 1059046 AK – 6113579 WP)/365/2): 40375