

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



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# 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

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# 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

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## 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

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## 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

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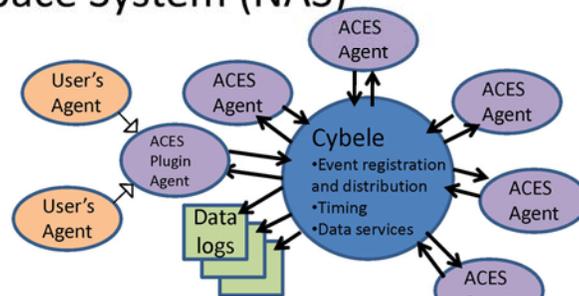
## ACES Simulation Overview

- 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

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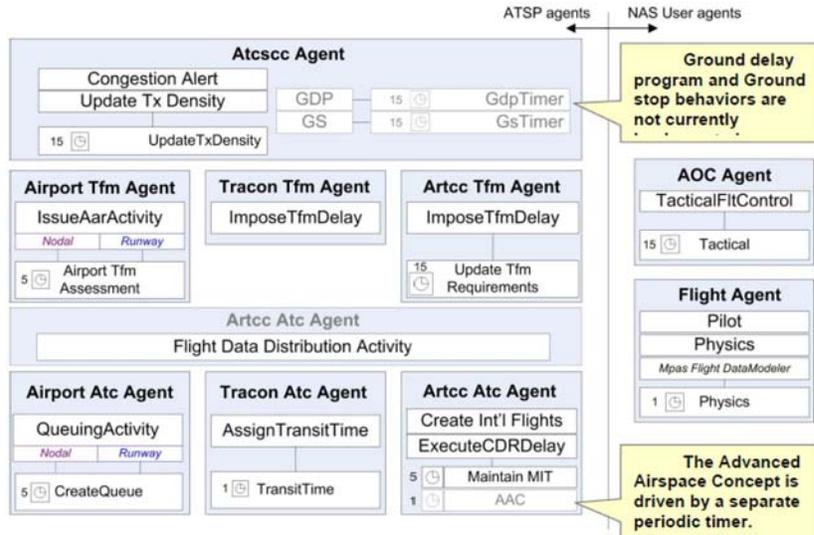
## ACES Capabilities

- 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)



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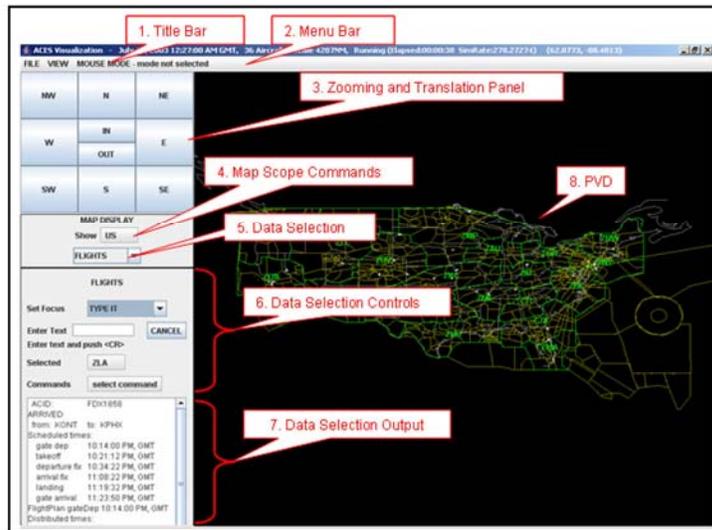
# ACES Overview



CDRL 18 ACES Programmer's Guide, Rev 2, p 13.

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# ACES Visualization



CDRL 17 Airspace Concept Evaluation System (ACES) User Guide, Version 4, p. 92.

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# ACES Demonstration

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

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# 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

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# ACES Viewer Demo

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

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# 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

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# ACES Capabilities

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

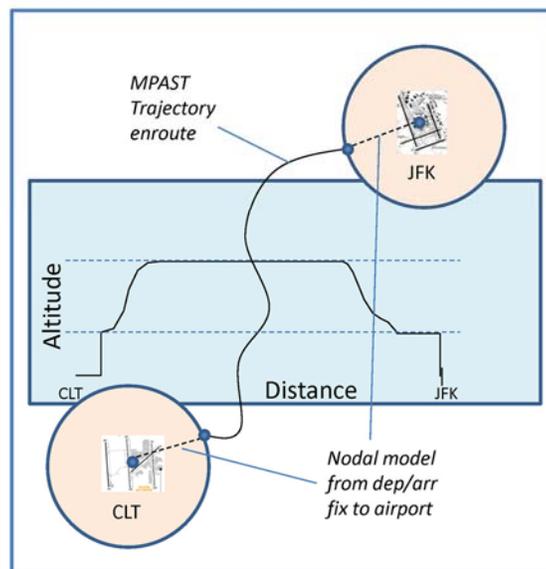
Nearby aircraft across Center boundary ignored



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# 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)



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## 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

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## 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

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## Current Status – M&S

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

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## 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

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## Current Status - CD&R

*Video of ACES  
simulation running  
with strategic CD&R  
enhancements*

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## 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

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# Questions/Discussion



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# Backup Slides

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## (Backup Slide) NAS Flights Estimates

### FAA's Terminal Area Forecast, 2010, page 18:

#### 2008 (last historic data available)

Yearly National Total Commercial (takeoffs and landings) (includes Alaska and West Indies)	27951930
Yearly Alaska	-937116
Yearly Western Pacific	<u>-4899428</u>
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
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