NASA Simulation Capabilities

Aug 7, 2017
ver. 072517b
Simulation Tool Overview

- The Future ATM (Air Traffic Management) Concepts Evaluation Tool (FACET) has provided a core capability to conduct air traffic management research for NASA’s Aeronautics Research Mission Directorate (ARMD) since 2000.

- Under the NASA-CAE agreement, FACET will be adapted to support simulations and analyses of Shanghai Pudong International Airport (IATA: PVG, ICAO: ZSPD) arrival and departure operations.
FACET Overview

- National Airspace System (NAS) - wide simulations and planning on a laptop computer
- Ability to model airspace operations at U.S. national level (~50,000 aircraft per day)
- Alternative navigation modes available
  - Flight Plan Routing
  - Great Circle Routing
  - Wind Optimal Routing
- Software written in ‘C’ and ‘Java’ programming languages
- Can be used for both off-line analyses and real-time applications
Sample of FACET Supported Studies

- “What-if” capabilities for evaluating traffic flow options to avoid bad weather and airspace congestion while minimizing air traffic delays
- Airspace performance metrics using operations data
  - Relationships between traffic, weather and delay
  - Techniques for clustering and data mining to identify similar types of days/operations
- U.S. domestic and Pacific wind optimal routing studies
- Aggregate air traffic flow models
  - Transform collections of similar trajectories into flow streams
  - Linear models with 100-fold order reduction

Sample “what-if” evaluation display
High-level FACET Architecture

- National Weather Service
  - Winds
  - Severe Weather
- Real-time and Historical Air Traffic Data
  - Tracks
  - Flight Plans
- Aircraft Performance Data
  - Climb
  - Descent
  - Cruise
- Adaptation Data
  - Airspace
  - Airways
  - Airports

FACET Core Features
- Route Parser & Trajectory Predictor
- Traffic & Route Analyzer
- User Interface

Sample Applications
- Airborne Self-Separation
- Data Visualization
- Direct Routing Analysis
- Controller Workload
- System-Level Optimization
- Traffic Flow Management
FACET Inputs

- FACET Interface Control Document (ICD) provides a comprehensive description of the system’s airspace adaptation and air traffic data requirements.

- Airspace adaptation requirements included for navigational aids, waypoints, airways, airport locations, Flight Information Regions (FIRs), sectors, Special Use Airspace (SUA), standard arrival and departure routes and airspace capacities.

- FACET formatted ASCII air traffic data format derived from the FAA’s System Wide Information Management (SWIM) data provided.

Note: FACET ICD is currently being reviewed and will be released shortly.
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## FACET Inputs :: Flight Information Region (FIR) / Center Boundary Example

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<th>FIR/Center Identifier</th>
<th>Min/Max Altitude</th>
<th>Latitude/Longitude of Vertex 1</th>
<th>...</th>
<th>Latitude/Longitude of Vertex N</th>
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![Map of Flight Information Regions](map-image)
### FACET Inputs :: Sector Example

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<th>Latitude/Longitude of Vertex N</th>
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## FACET Inputs :: Air Traffic Example

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<th>375900</th>
<th>835700</th>
<th>516</th>
<th>366</th>
<th>69</th>
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<td>Unix epoch time in seconds since Jan. 1 1970 (midnight UTC/GMT)</td>
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</tr>
</tbody>
</table>

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**FP_ROUTE**: KDFW/LMEM359067..RBV..RIFLE..ACK..TUSKY.YQX.NATY.LIMRI.DOLIP.CRK.EXMOR.GIBSO.EGKK

Flight plan route

Flight plan route
FACET Application Programming Interface

- FACET Application Programming Interface (API) enables scripting of FACET functionality from Java, Jython, Matlab, etc.
- Over 600 methods for accessing FACET functionality
Predefined FACET output capabilities provide:
- Aggregate aircraft counts in FIRs/Centers/Sectors, arrivals, departures and user defined traffic streams
- Aircraft-level statistics available for displaying aircraft state information (e.g., heading, speed, altitude, etc.) versus time, fuel burn, path distance and length, etc.

FACET Application Programming Interface (API) provides complete access to all aircraft state information for user defined metrics calculations.