

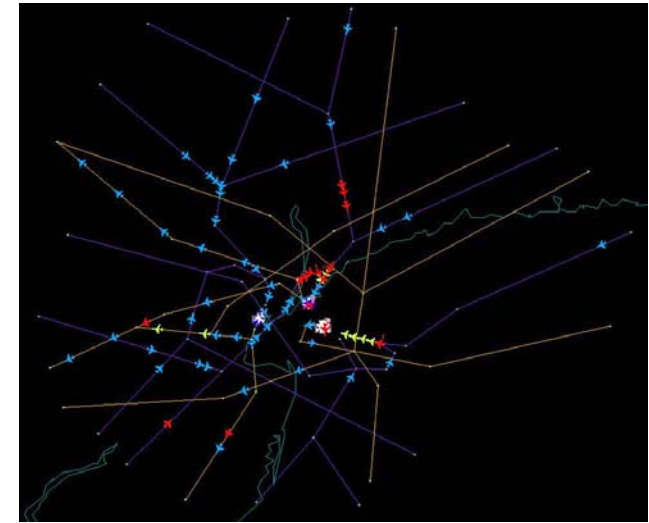
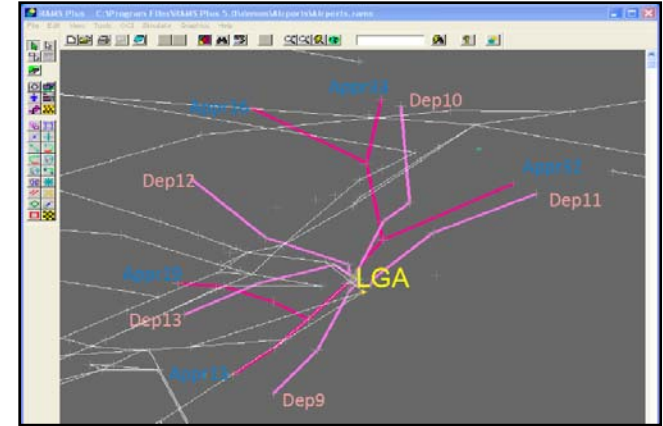
Database of Modeling and Simulation Tools

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Introduction

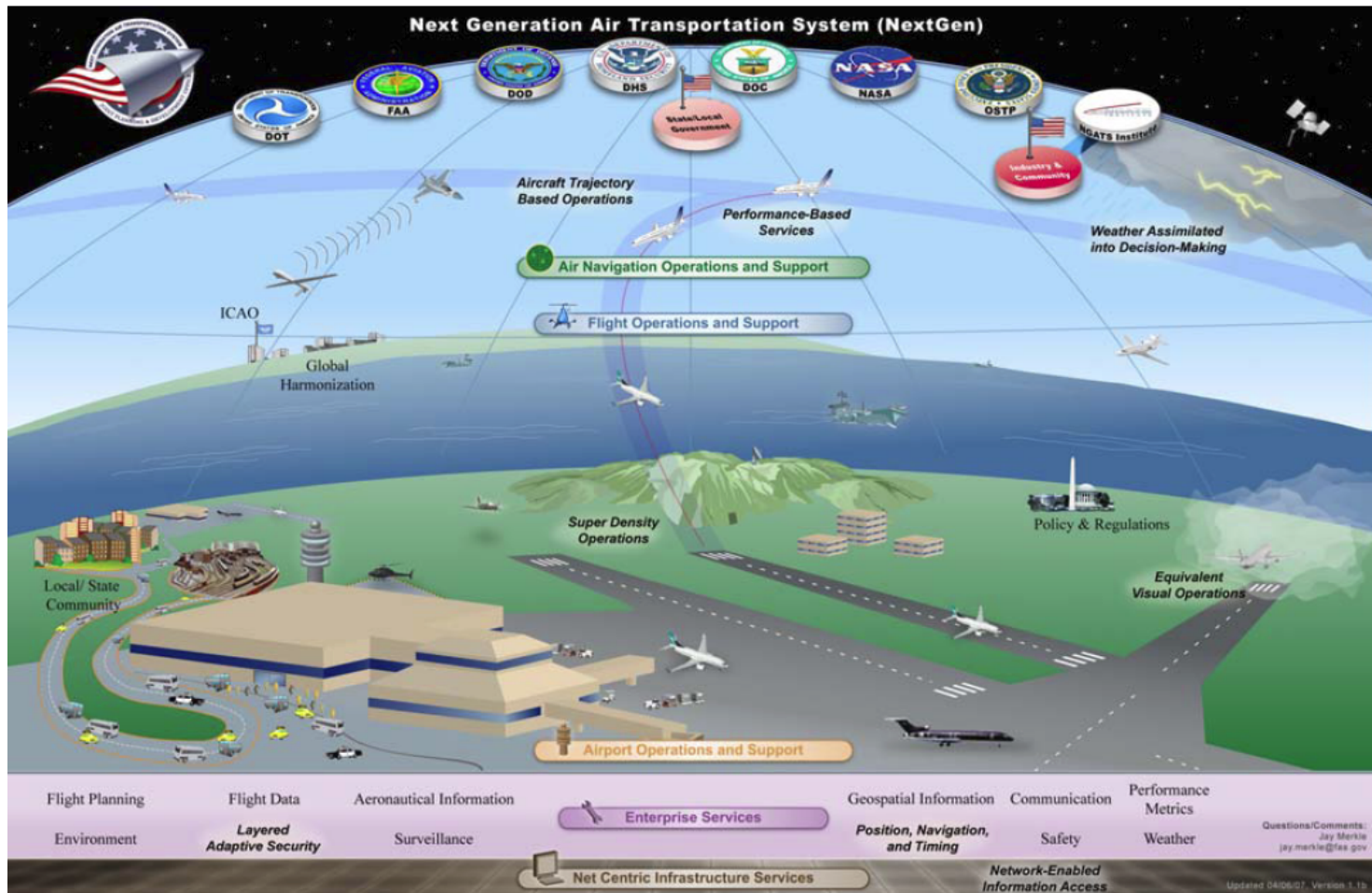
- A wide variety of tools and models are in use by government agencies and industry to identify system constraints and to assess the benefits of new concepts or technologies
- Identify and catalog these modeling and analysis tools for potential future use by the NASA Airportal Project
- Identify gaps in current modeling and analysis capabilities



Aviation Model Classifications

- There are many ways to classify aviation models
 - By purpose application (capacity and delay, noise, aircraft performance, conflict, etc.)
 - By level of detail (macroscopic, mesoscopic and microscopic)
 - By execution style (fast-time, real-time)
 - By methodology used in the computations (simulation-based or analytical)
 - By type of model parameters and variables (stochastic or deterministic)
 - By scope of application (airside, landside; terminal area, runway)

NextGen Components



Source: JPDO NextGen CONOPS v.2

Eight Fundamental NextGen Capabilities

- Network-enabled information systems (NEIS)
- Performance-based operations and services (PBO)
- Weather assimilated into decision making (WxDM)
- Layered, adaptive security (LAS)
- Positioning, Navigation and Timing (PNT) services
- Aircraft Trajectory-Based Operations (TBO)
- Equivalent Visual Operations (EVO)
- Super-Density arrival and departure Operations (SDO)

Approach

1. Start with a comprehensive list of models to be reviewed
2. Establish a mapping between NextGen capabilities and the models in previous task (by scope or domain)
3. Select the intersection of the models and NextGen capabilities that present relevant issues to the airportal project
4. Identify and catalog these modeling and analysis tools for potential future use by the NASA Airportal Project
5. For the selected NextGen capabilities define some case studies to study adequacy of the models
6. Identify capabilities required, and gaps in available tools, for conducting sub-system/system level trade and benefit studies

Example Models Used in Capacity and Delay Analyses

System Level	Landside/ Security	Apron/Taxi ways	Runways and Close Airspace	Terminal Area	Enroute
Macroscopic (Policy Analysis)	ACRP Spreadsheet Model		LMI Runway REDIM FAA ACM DELAYS Boeing Runway AND	SDAT	SDAT
Mesoscopic (Traffic Flow)	ALSIM		ACATS	NASPAC FACET LMINet systemWideMod eler	NASPAC FACET AWSIM ACES LMINet systemWideMod eler
Microscopic (Detailed Analysis)	Transolutions Land Side Model Others	SIMMOD Plus/Pro RAMS TAAM VTAsim	SIMMOD Plus/Pro RAMS TAAM ACE*	SIMMOD Plus/Pro RAMS TAAM ACES	SIMMOD Plus/Pro RAMS TAAM ACES

Sample Applicability of Models Used in Capacity and Delay Analyses / Mapping to NextGen

NextGen Element	Landside	Apron/Taxi ways	Runways and Close Airspace	Terminal Area	Enroute
SDO	Not Applicable	Yes SIMMOD +/-pro RAMS TAAM VTAsim	Yes SIMMOD +/-pro RAMS TAAM ACATS LMI Runway REDIM FAA ACM DELAYS Boeing Runway	Yes SIMMOD +/-pro RAMS TAAM ACES*	Not Applicable

Other Types of Models

System Level	Noise and Emissions	Safety	Aviation Demand	Human Automation	Conflict Detection and Resolution
Mesoscopic	FAA EDMS		FAA Terminal Area Forecast		FACET AWSIM
Microscopic	FAA INM 7.0 NIRS	TOPAZ	TSAM AVdemand	Air MIDAS	SIMMOD +/-Pro RAMS TAAM ACES

What We Want to Do

- Study in detail all CONOPS plans contained in NextGen documents
- Identify and catalog modeling and analysis tools for potential use by the NASA Airportal Project
- Identify gaps in current modeling and analysis capabilities
- Recommendations on capabilities and toolset/techniques will be provided

Current Progress

- Assembled all papers associated with aviation models in a series of EndNote libraries

Sample
Noise-related
Papers
With INM
Content

Author	Year	Title	Journal
Arafa	2007	Noise assessment and mitigation schemes for Hurgada airport	Applied Acoustics
Asdrubali	2003	An expert system to record and evaluate aircraft environmental noise	
Asensio	2007	Estimation of directivity and sound power levels emitted by aircrafts during ...	Applied Acoustics
Brown	1994	INM contour validation - a case study	
Chapkis	1980	IMPACT OF TECHNICAL DIFFERENCES BETWEEN THE METHODS OF I...	Proceedings - International Conference on Noise Control Engineer
Ciesielka	2007	Management of environmental noise - The Cracow example	Archives of Acoustics
Clemente	2005	Sensitivity of the FAA Integrated Noise Model to input parameters	Applied Acoustics
Connor	1980	INTEGRATED NOISE MODEL - THE FEDERAL AVIATION ADMINISTRATI...	Proceedings - International Conference on Noise Control Engineer
Eagan	2007	Supplemental metrics to communicate aircraft noise effects	Transportation Research Record
Ehrlich	2004	A typical case study of school sound insulation	Sound and Vibration
Foster	1978	MODELLING AS A MEANS TO ASSESS NOISE IMPACT	SAE Preprints
Isermann	1986	PREDICTION OF AIRCRAFT NOISE AROUND AIRPORTS BY A SIMULATI...	
Jennings	1990	Analysis of the impacts of parameter uncertainty on integrated noise model...	Proceedings of the International Conference on Development and
Larson	1994	Present and future of aircraft noise models: a user's perspective	
Looten	2003	Effects of frequency weighting networks on aircraft noise measurements a...	
Matsoukis	2002	Noise pollution due to air and road traffic at Corfu's international airport (Greece)	
Ren	2005	Development and application of separation analysis methodology for nois...	
Roling	2007	Evaluation of London heathrow using the airport business suite	
Sharman	2004	Reducing the impact of noise abatement practices on airport capacity by fo...	
Trozzi	1996	AIR AIR & NOISE air pollutants emissions and noise from airports	
Tsouka	1992	Meteorological impacts on airport noise prediction by the 'integrated noise ...	Inter-Noise: Proceedings
Xu	2006	A preliminary assessment of airport noise and emission impacts induced b...	
Yang	2005	Applying neural networks and geographical information systems to airport ...	
Zografos	2007	Advanced modeling capabilities for airport performance assessment and c...	Transportation Research Record

Showing 24 out of 24 references.

Model Evaluation Form Information

- Model Name
 - Modeling Domain
 - Executive Summary
 - Model Inputs
 - Model Outputs
 - Model Algorithms
(vehicle, environment, interaction, ATC etc.)
 - Hardware/Software Implementation Issues
 - Program Design and Extensibility
 - Validation Efforts
- Current Status
 - Future Directions (if known)
 - Previous Applications
 - Mapping of Model to NextGen Concepts
 - Perceived Gaps
 - Model Documentation
 - Reports and Papers Using the Model
 - Sample Screens (optional)
 - Availability and Cost
 - Developer Contact Information

Aviation Model Database Information

- Because each aviation model considered has multiple pieces of information (input, output, design, etc.) and multiple resources (such as documentation, papers, animations etc.) we decided to organize the information in a database manager
- Filemaker Pro 9.0 Advanced (Macintosh and Windows compatible) is used for this purpose
- Filemaker Pro Advanced can export the database to a stand-alone, run-time web application if needed

Screen Capture of Aviation Model Database

Database Navigation Tabs

The screenshot displays the 'NextGen Aviation Model Library' interface. At the top, there are navigation tabs: Main, Summary, Inputs, Outputs, Algorithms, Hardware, Design, Validation, Applications, NextGen, Documentation, and Availability. The 'Main' tab is selected. Below the tabs, the model details for 'Reorganized ATC Mathematical Simulator' are shown:

- Mode Name:** Reorganized ATC Mathematical Simulator
- Short Name:** RAMS Plus
- Model Domains:** Terminal Area, Enroute, Apron/Taxiway
- Level of Application:** Microscopic
- Current Version:** 5.2.27
- Operating System:** Windows
- Year of Development:** 1992
- Contact Information:** ISA Software
- Model Applications:** ATC Workload
- NextGen Applications:** Super Density Operations, Trajectory Based Operations
- Brief Summary:** A fast-time simulation model developed by Eurocontrol to study ATC sector workload. The model has been enhanced by ISA Software over the past 8 years to include airport simulation objects such as detailed runways, taxiways and gate elements. The model employs table functions to

To the right of the model details is a 'Sample Picture' showing an airport diagram with various flight paths and labels such as 'Appr12', 'Appr13', 'Dep10', 'Dep11', 'Dep12', 'Dep13', 'Appr14', 'Appr15', and 'LGA'.

Sample Database Query

(Find all Models in the Terminal Area Domain)

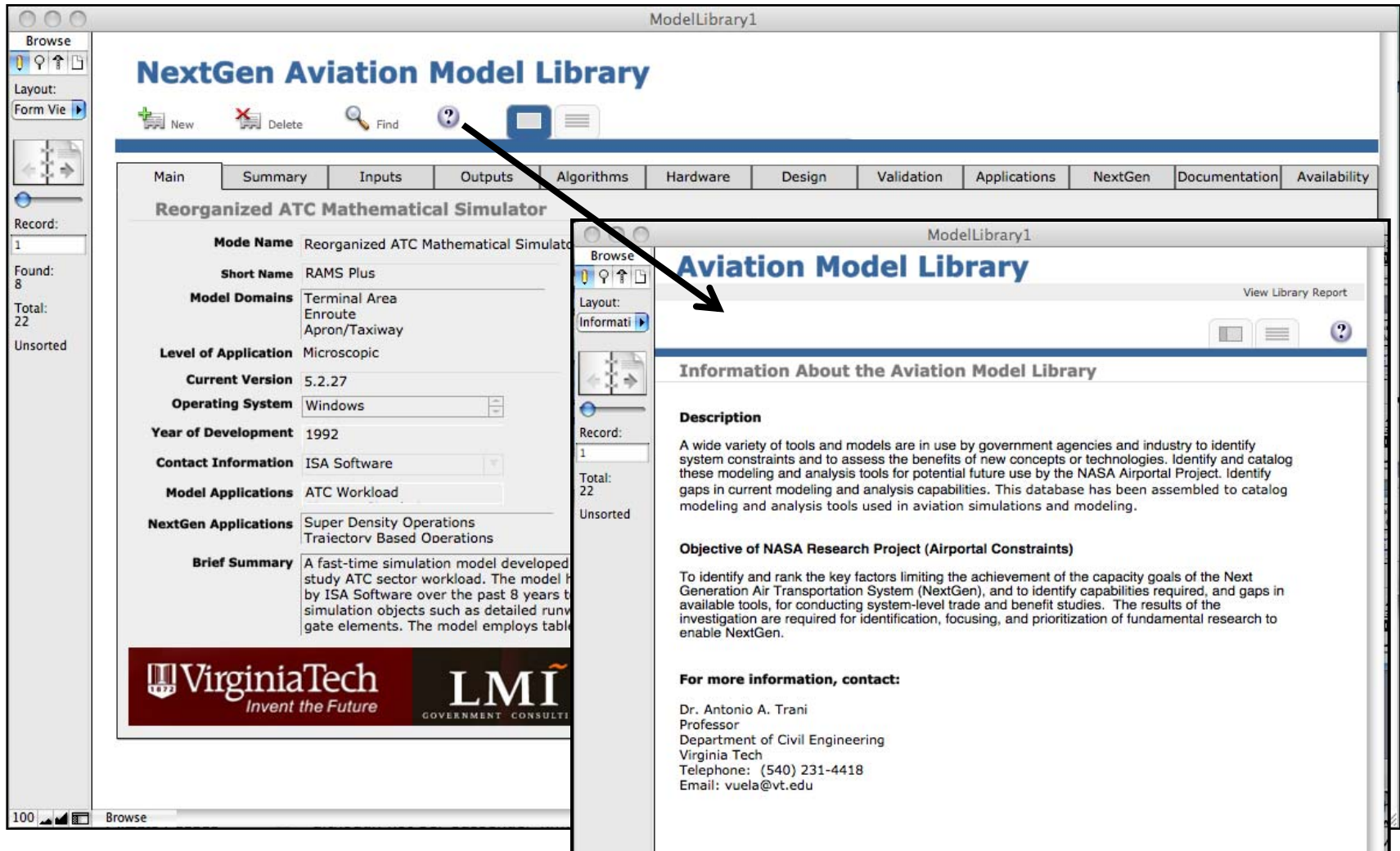
The screenshot shows the 'NextGen Aviation Model Library' interface. A search bar at the top contains the text 'Reorganized ATC Mathematical Simulator'. Below the search bar, a list of results is displayed. The first result is selected and its details are shown in a large panel on the right. The details panel includes fields for Mode Name, Short Name, Model Domains, Level of Application, Current Version, Operating System, Year of Development, Contact Information, Model Applications, NextGen Applications, and a Brief Summary. A 'Sample Picture' is also included, showing a network diagram of flight paths around LGA airport.

Model Details:

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- Short Name:** RAMS Plus
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Sample Picture: A network diagram showing flight paths (Appr10, Appr11, Appr12, Appr13, Dep9, Dep10, Dep11, Dep12, Dep13) converging on LGA airport.

Sample Database Information (Help Information)



The screenshot displays the 'NextGen Aviation Model Library' software interface. The main window shows a list of models, with the 'Reorganized ATC Mathematical Simulator' selected. A detailed view of this model is shown on the left, and a help window is open on the right.

Model Details:

- Mode Name:** Reorganized ATC Mathematical Simulator
- Short Name:** RAMS Plus
- Model Domains:** Terminal Area, Enroute, Apron/Taxiway
- Level of Application:** Microscopic
- Current Version:** 5.2.27
- Operating System:** Windows
- Year of Development:** 1992
- Contact Information:** ISA Software
- Model Applications:** ATC Workload
- NextGen Applications:** Super Density Operations, Trajectory Based Operations
- Brief Summary:** A fast-time simulation model developed to study ATC sector workload. The model is based on data collected by ISA Software over the past 8 years to represent simulation objects such as detailed runway and gate elements. The model employs tabular data to represent the simulation objects.

Help Window: Information About the Aviation Model Library

Description

A wide variety of tools and models are in use by government agencies and industry to identify system constraints and to assess the benefits of new concepts or technologies. Identify and catalog these modeling and analysis tools for potential future use by the NASA Airportal Project. Identify gaps in current modeling and analysis capabilities. This database has been assembled to catalog modeling and analysis tools used in aviation simulations and modeling.

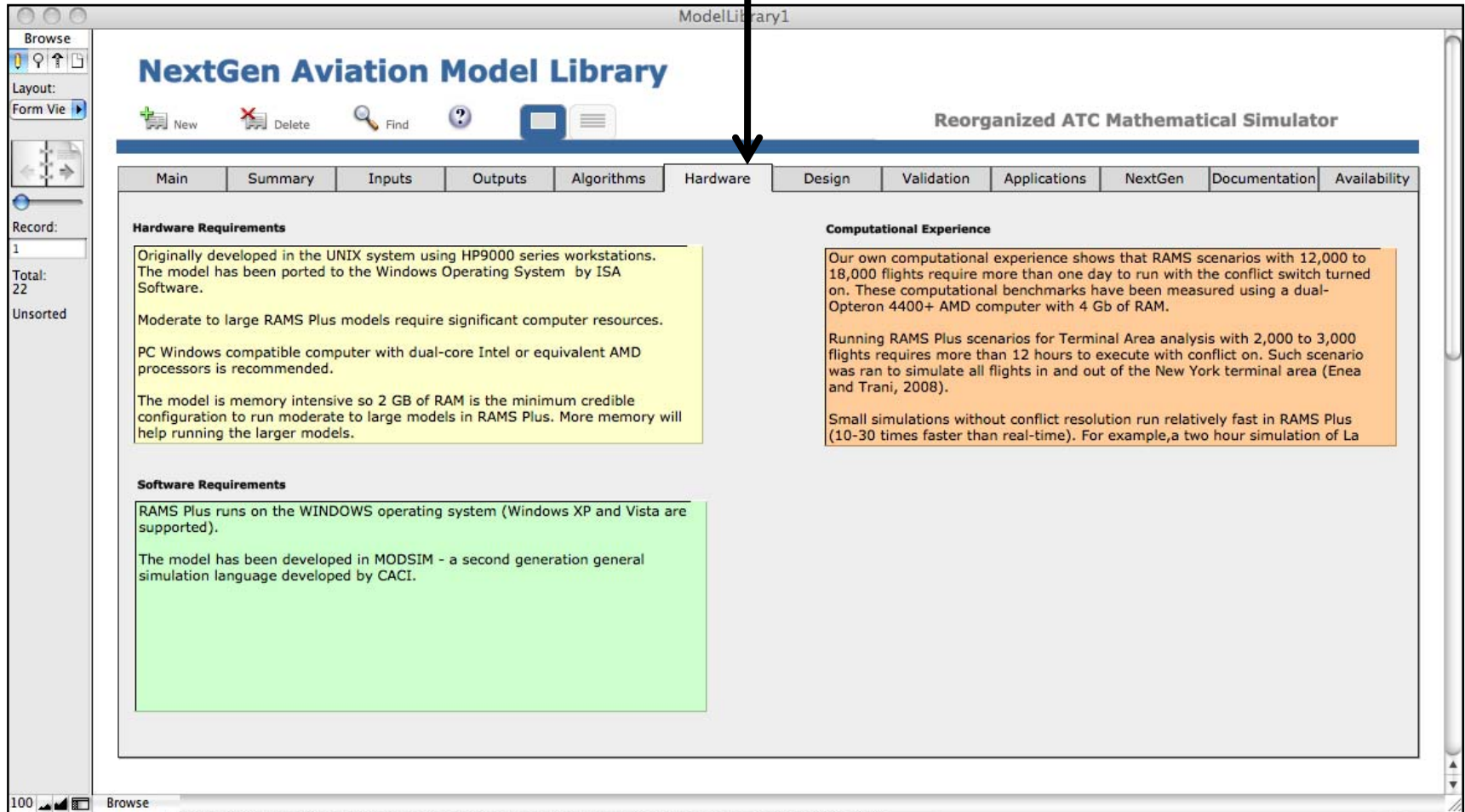
Objective of NASA Research Project (Airportal Constraints)

To identify and rank the key factors limiting the achievement of the capacity goals of the Next Generation Air Transportation System (NextGen), and to identify capabilities required, and gaps in available tools, for conducting system-level trade and benefit studies. The results of the investigation are required for identification, focusing, and prioritization of fundamental research to enable NextGen.

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Sample Hardware/Software Tab Information Aviation Model Database



ModelLibrary1

NextGen Aviation Model Library

Reorganized ATC Mathematical Simulator

New Delete Find ? [Icon] [Icon]

Main Summary Inputs Outputs Algorithms **Hardware** Design Validation Applications NextGen Documentation Availability

Hardware Requirements

Originally developed in the UNIX system using HP9000 series workstations. The model has been ported to the Windows Operating System by ISA Software.

Moderate to large RAMS Plus models require significant computer resources.

PC Windows compatible computer with dual-core Intel or equivalent AMD processors is recommended.

The model is memory intensive so 2 GB of RAM is the minimum credible configuration to run moderate to large models in RAMS Plus. More memory will help running the larger models.

Software Requirements

RAMS Plus runs on the WINDOWS operating system (Windows XP and Vista are supported).

The model has been developed in MODSIM - a second generation general simulation language developed by CACI.

Computational Experience

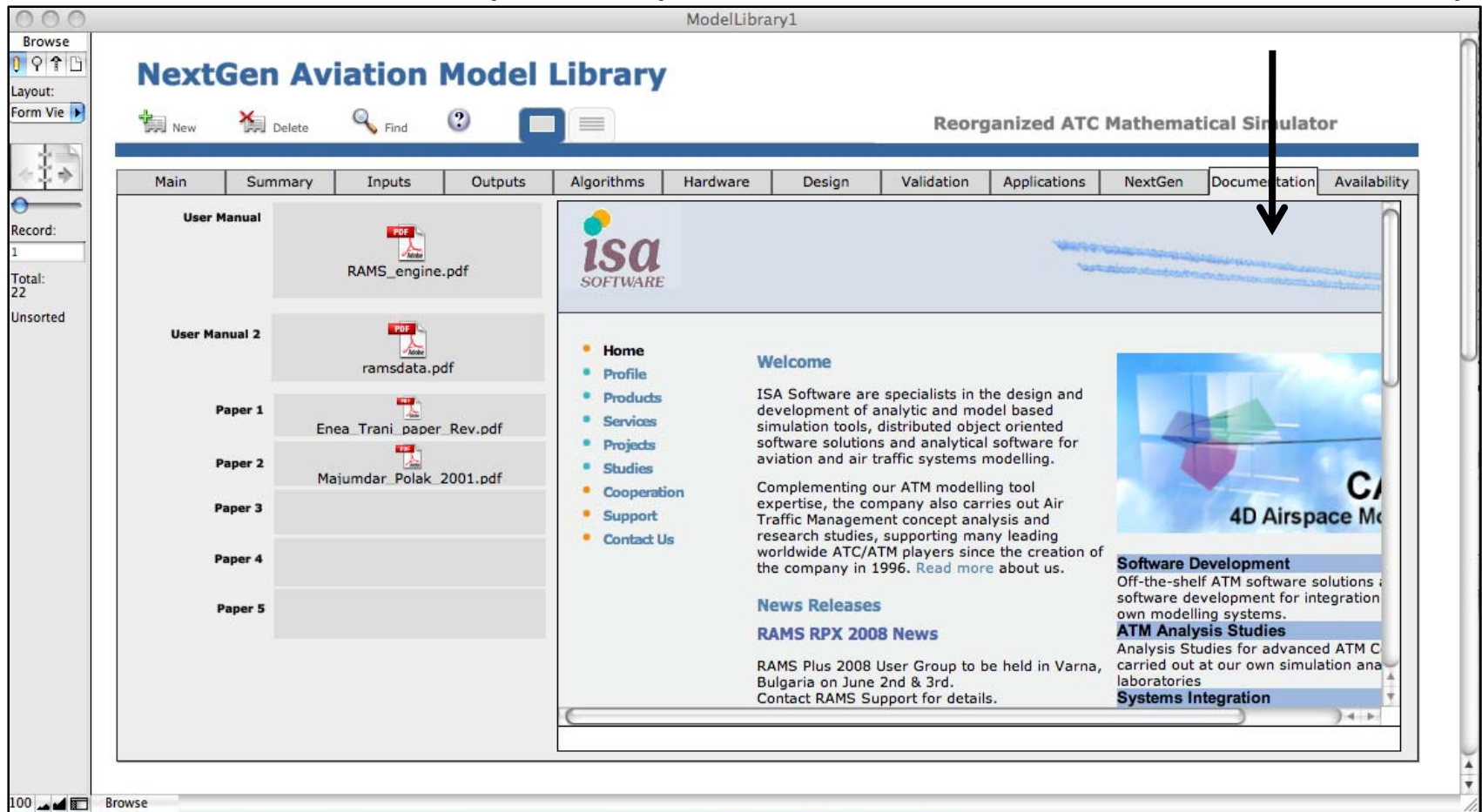
Our own computational experience shows that RAMS scenarios with 12,000 to 18,000 flights require more than one day to run with the conflict switch turned on. These computational benchmarks have been measured using a dual-Opteron 4400+ AMD computer with 4 Gb of RAM.

Running RAMS Plus scenarios for Terminal Area analysis with 2,000 to 3,000 flights requires more than 12 hours to execute with conflict on. Such scenario was ran to simulate all flights in and out of the New York terminal area (Enea and Trani, 2008).

Small simulations without conflict resolution run relatively fast in RAMS Plus (10-30 times faster than real-time). For example, a two hour simulation of La

Documentation Tab Information

Contains Model Manuals, Reports, Papers and Web Connection to Model Developer



The screenshot shows the 'NextGen Aviation Model Library' web application. The title bar indicates the window name is 'ModelLibrary1'. The main header features the application title and the subtitle 'Reorganized ATC Mathematical Simulator'. A navigation menu at the top includes tabs for 'Main', 'Summary', 'Inputs', 'Outputs', 'Algorithms', 'Hardware', 'Design', 'Validation', 'Applications', 'NextGen', 'Documentation', and 'Availability'. The 'Documentation' tab is currently selected and highlighted with a black arrow. The left sidebar contains a 'Browse' section with a 'Form View' dropdown and a 'Record:' field showing '1' out of 'Total: 22' 'Unsorted' items. The main content area displays the 'ISA SOFTWARE' logo and a navigation menu with links for Home, Profile, Products, Services, Projects, Studies, Cooperation, Support, and Contact Us. A 'Welcome' message follows, describing ISA Software's expertise in design and development of analytic and model-based simulation tools. Below this, there are sections for 'News Releases' (RAMS RPX 2008 News) and 'Software Development'. The left sidebar lists several documents: 'User Manual' (RAMS_engine.pdf), 'User Manual 2' (ramsdata.pdf), and five 'Paper' entries (Enea_Trani_paper_Rev.pdf, Majumdar_Polak_2001.pdf, and three empty entries).

