

System Wide Modeling for the JPDO

Shahab Hasan, LMI

Presented on behalf of Dr. Sherry Borener, JPDO EAD Director

Nov. 16, 2006



Outline

- **Quick introduction to the JPDO, NGATS, and EAD**
- **Modeling Overview**
- **Constraints Analysis**
- **Portfolio Analysis**

Outline

- **Quick introduction to the JPDO, NGATS, and EAD**
- **Modeling Overview**
- **Constraints Analysis**
- **Portfolio Analysis**

What is the JPDO?

- **Joint Planning and Development Office**
 - <http://www.jpdo.aero/>
- Interagency effort: FAA, NASA, Departments of Transportation, Defense, Homeland Security, and Commerce, and Office of Science and Technology Policy
- Coordinated federal effort to apply R&D resources to address current and looming issues with the nation's air transportation system
 - Focused on the far-term, rather than incremental modernization
- Ultimate product is the Next Generation Air Transportation System (NGATS or NextGen)

JPDO Goals



What is the NGATS?

- **Next Generation Air Transportation System**
- The “end state” of the JPDO’s work (2025)

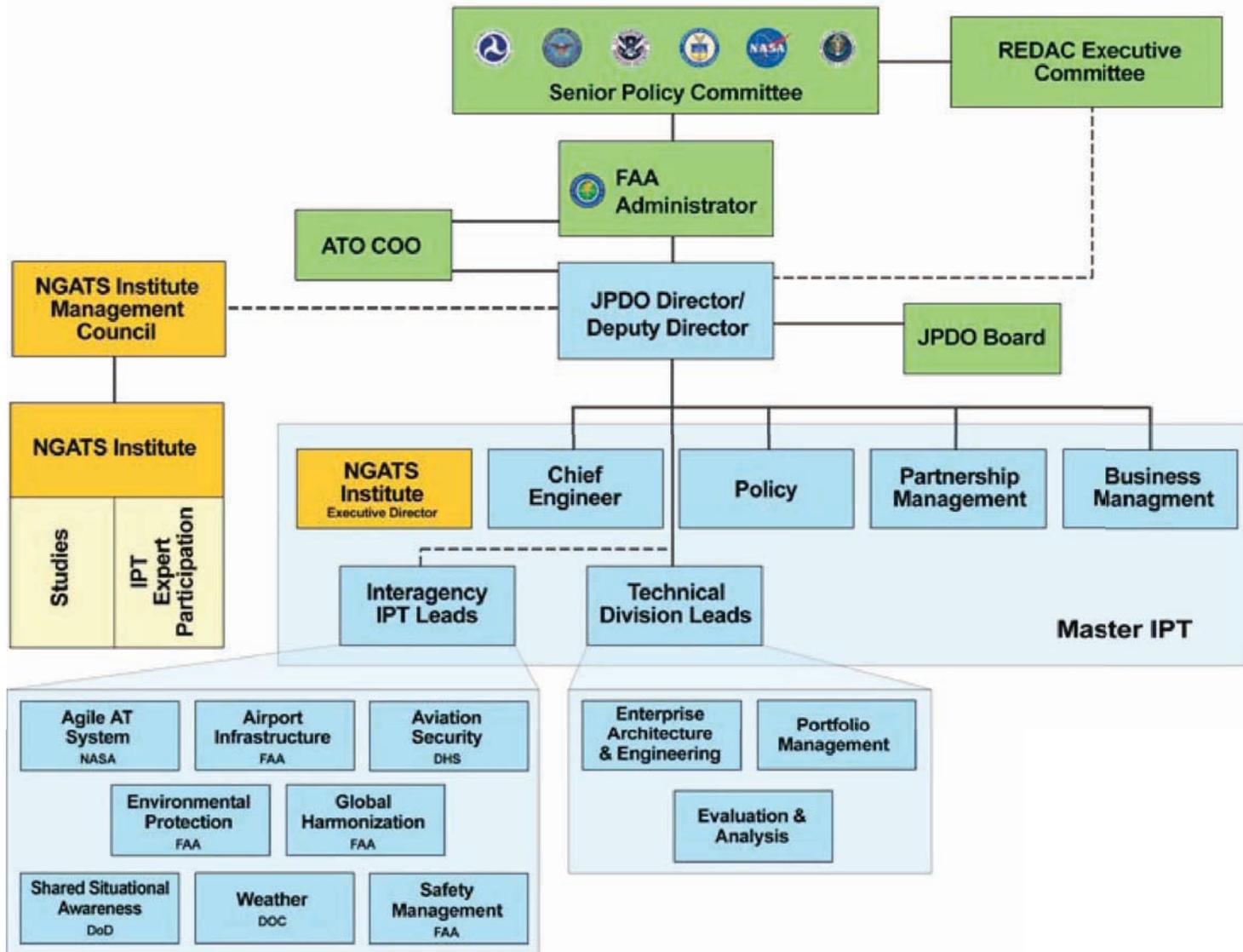
Operating Principles

- “It’s about the users...”
- System-wide transformation
- Prognostic approach to safety assessment
- Globally harmonized
- Environmentally compatible to foster continued growth

Key Capabilities

- Net-Enabled Information Access
- Performance-Based Services
- Weather-Assimilated Decision Making
- Layered, Adaptive Security
- Broad-Area Precision Navigation
- Trajectory-Based Aircraft Operations
- “Equivalent Visual” Operations
- “Super Density” Operations

JPDO Organization



EAD Mission and Team

The Evaluation and Analysis Division (EAD) assesses strategies for transforming the NAS and meeting the high level national goals and provides the JPDO principals with trade-offs. This provides the knowledge necessary to prioritize JPDO investments.

- **Assess the impact of JPDO operational improvements:**
 - **Benefit pools:** estimate the benefits envelope
 - **Estimated benefits:** estimate benefits of specific improvements

Outline

- Quick introduction to the JPDO, NGATS, and EAD
- **Modeling Overview**
- Constraints Analysis
- Portfolio Analysis

Major Dimensions of the Air Transportation System

A. Pax/Cargo Demand

- 1) Current (1X)
- 2) TAF & TSAM Growth to 2014 & 2025 (1.2X, 1.4X)
- 3) 2X TAF/TSAM Based Constrained Growth
- 4) 3X TAF/TSAM

B. Fleet Mix/ Aircraft Types

- 1) Current Scaled
- 2) More Regional Jets
- 3) New & Modified Vehicles
 - Microjets
 - UAVs
 - E-STOL/RIA
 - SST
 - Cleaner/ Quieter

C. Business Model/ Schedule

- 1) Current (mostly Hub & Spoke)
- 2) More Point to Point + Regional Airports
- 3) Massive Small Airport Utilization

D. NAS Capability

- 1) Current
- 2) 2014 OEP
- 3) Increased Capacity of:
 - Landside
 - Surface
 - Runways
 - Terminal
 - En route
- 4) Systemic:
 - CNS
 - SWIM
 - Wx Prediction

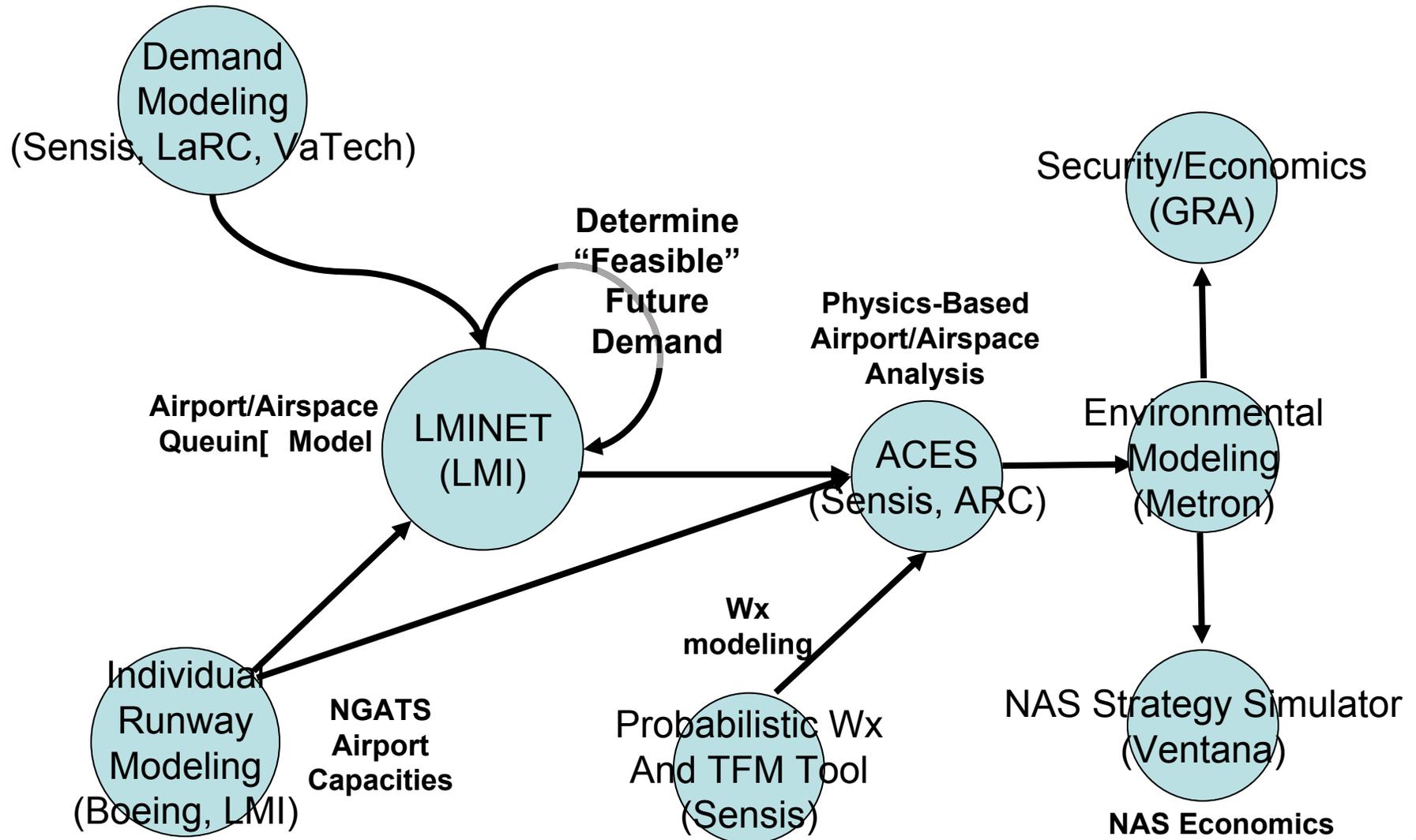
E. Disruptions /Weather

- 1) Good Weather (Wx)
- 2) Bad Weather
 - Airport IFR
 - En route
 - 7 Wx days
- 3) Disruption
 - Sudden Shutdown of an airport or region

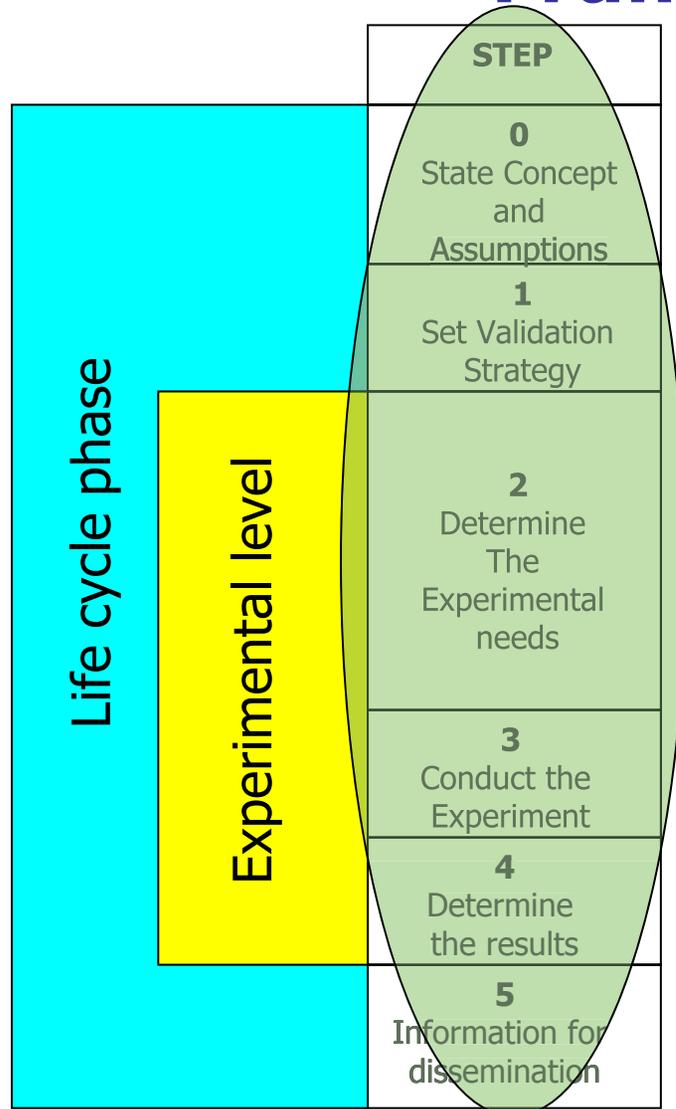
EAD Modeling and Simulation Tools

- **ACES** (NASA-Ames/Sensis): Agent-based simulation of individual aircraft flying one day of NAS activity
- **LMINET** (LMI): Queuing model for airports and sectors of one day of NAS activity.
- **ProbTFM Tool** (Sensis): Tool for designing and evaluating probabilistic traffic flow management in heavy weather
- **AvDemand** (Sensis): Calculates future NAS demand based on FAA forecasts
- **AvAnalyst** (Sensis): Analysis and visualization tool for NASA ACES simulation outputs
- **TSAM** (LaRC, VaTech): Transportation Systems Analysis Model – demand generation and NAS-wide modeling and analysis
- **NAS-Wide Environmental Impact Model** (Metron, NASEIM): Detailed calculator of noise and emissions based on individual flight trajectories from ACES
- **GRA Screening Model** (GRA): For each passenger service airport, model describing current security lanes and processing rates; may be adapted for additional lanes or changes in processing rates
- **FAA NAS Strategy Simulator** (Ventana): Multi-year, macro-level simulation of annual system statistics of demand, NAS activity, FAA costs and revenues
- **Airport Capacity Constraints Model** (Boeing): For 35 OEP airports, computes detailed capacity as a function of runway configuration, operational procedures, and ground infrastructure.

EAD Integrated Modeling and Analysis Process

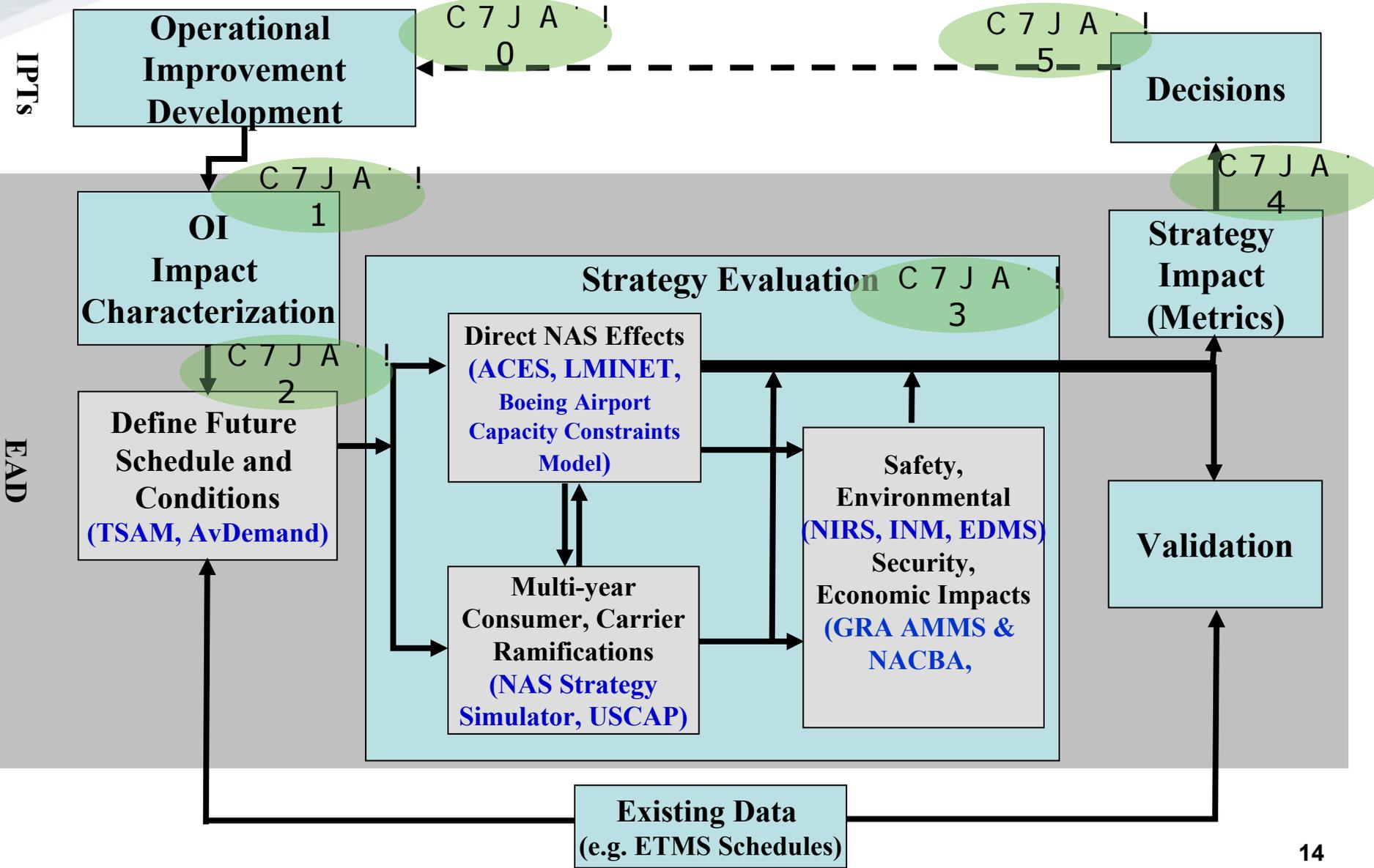


JPDO and Eurocontrol Development Frameworks



- Eurocontrol has defined a framework for ATM development programs called the European Operational Concept Validation Methodology (E-OVCM)
- ***JPDO EAD modeling and analysis process aligns closely with the E-OVCM framework***
- ***EAD will incorporate and adapt best-practices from the E-OVCM in the evaluation and assessment of the NGATS Concept of Operations***

EAD Modeling and Analysis Framework



Outline

- Quick introduction to the JPDO, NGATS, and EAD
- Modeling Overview
- **Constraints Analysis**
- Portfolio Analysis

High-level Constraints Analysis Overview and Approach

- The purpose of this high-level constraints analysis was to examine and quantify the primary factors limiting NAS performance and growth, including capacity, environment, safety, security, and costs
 - Identify and quantify the “tall pole in the tent”
 - This can inform agency research and development plans to focus on key areas to help achieve the NGATS Goals
- This initial analysis approach was
 - Focused ONLY on *capacity and environment*
 - Performed sequentially – with capacity constraints applied against unconstrained demand, and the capacity-constrained demand used as an input to the environmental constraints analysis
 - *Only the capacity results are being briefed here*

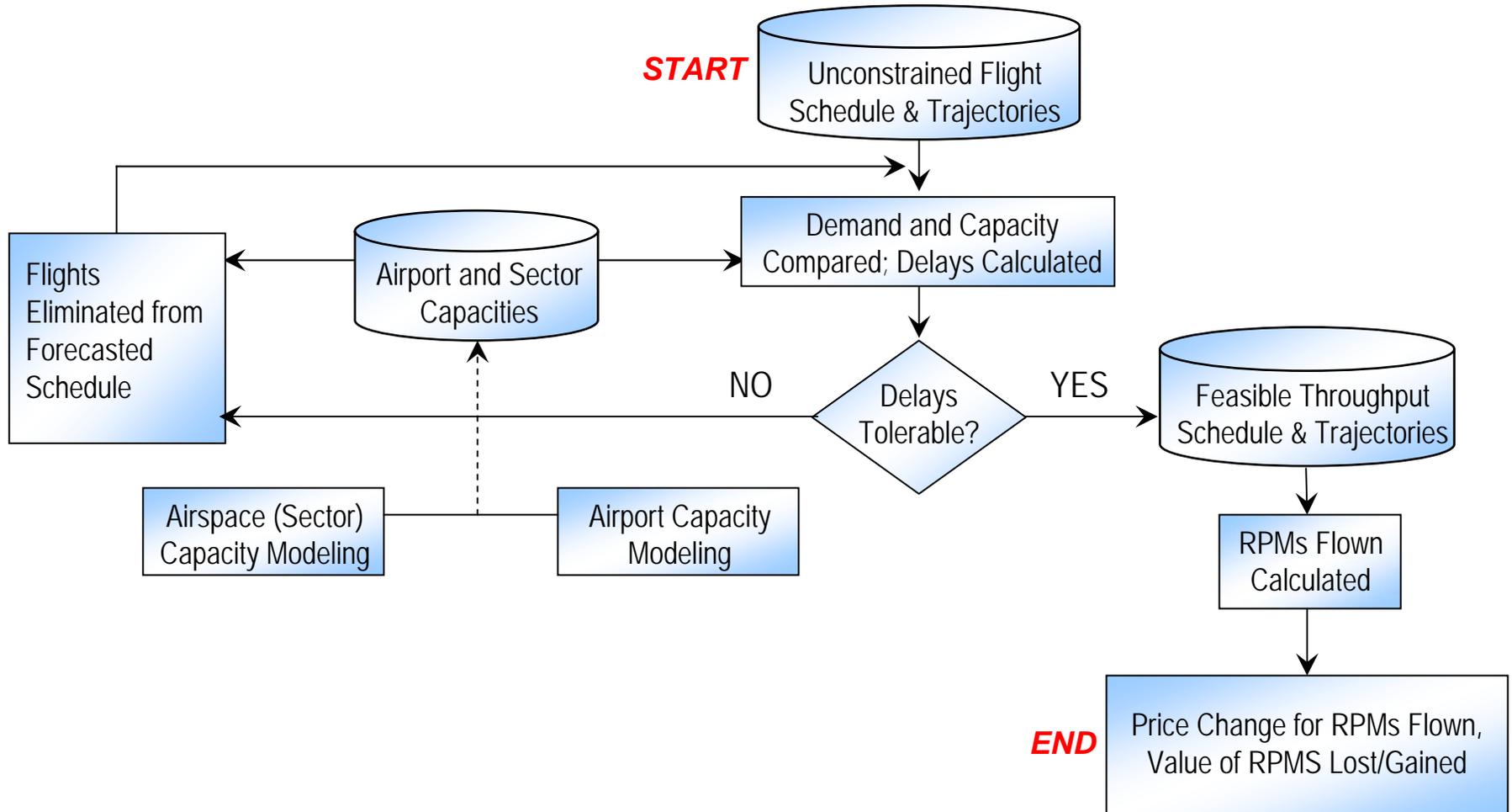
Capacity Constraints Analysis Objective

- We know that there are many facets of National Airspace System (NAS) capacity
 - Runways, taxiways, gates, en route sectors
- At a macro level, for this analysis, we have lumped capacity into only two categories: en route and airport
 - *This is a simplifying assumption made to accommodate NAS-wide modeling*
- We wanted to see which of these two categories constrains NAS performance first and to what degree

Capacity Analysis Approach: from Unconstrained Demand to Feasible Throughput

- “Unconstrained demand” (e.g., the FAA’s Terminal Area Forecast) represents the public’s desire for air transportation regardless of whether sufficient future NAS capacity will exist
- Without sufficient capacity, future flight schedules would incur unrealistically large delays if all demanded flights actually flew
- Our premise is that capacity constraints would force some of the demand to be left unsatisfied, thus we analytically remove flights from the future flight schedule after a specified airport delay tolerance or sector capacity is reached
- We call this consolidated capacity metric “***feasible throughput***” which estimates the number of flights that would be scheduled and flown for a given level of airport delay and sector capacity

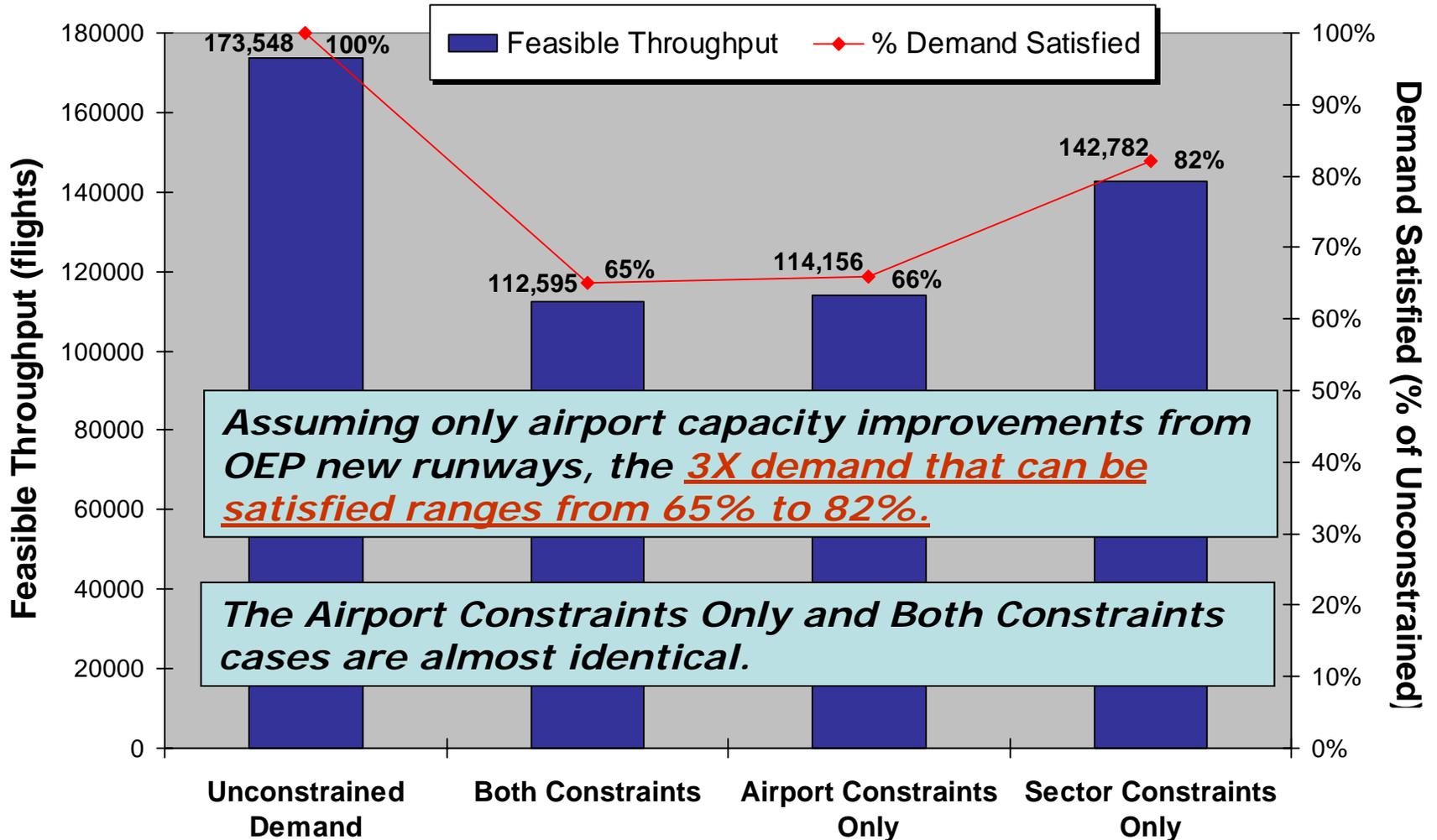
Capacity Analysis Methodology



Capacity Analysis Approach: Details

- Looked at a 3X demand (in terms of flights) scenario
 - Started with a current (2004) demand set and extrapolated the demand to 3X based on TAF growth rates
 - Preserved the current prevailing business model (hub & spoke), fleet mix, schedule time-of-day patterns, flight trajectories, and other parameters
- Simulation models run in three configurations
 1. Both airport and sector constraints active
 2. Sector constraints active but airport capacity assumed to be unlimited
 3. Airport constraints active but sector capacity assumed to be unlimited
- Estimated the feasible throughput based on the following assumptions
 - Airport capacities based on 2014 Operational Evolution Plan (OEP) airport capacities
 - Airspace capacities based on current sector capacities (MAP values)
 - Good weather analysis only

3X Demand Scenario Results



Capacity Constraints Analysis Conclusions

- To satisfy 3X demand, both types of constraints must be resolved
- Airport constraints are more binding
 - If only the sector constraints are resolved, overall NAS-wide performance remains severely constrained
 - Just a 1% improvement in feasible throughput
 - If only the airport constraints are resolved, overall NAS-wide performance still benefits significantly
 - However, even then, significant sector constraints remain that prevent the system from satisfying all the unconstrained demand
- Bear in mind our simplifying assumption of segregating capacity into airport and en route and that this analysis was for good-weather only

Outline

- Quick introduction to the JPDO, NGATS, and EAD
- Modeling Overview
- Constraints Analysis
- **Portfolio Analysis**

EAD Portfolio Analysis Objectives

What

Quantify and communicate how well the NGATS investment portfolio meets NGATS goals

How

- Express investment outcomes as operational changes
- Using simulations and expert input, estimate net system performance due to those changes

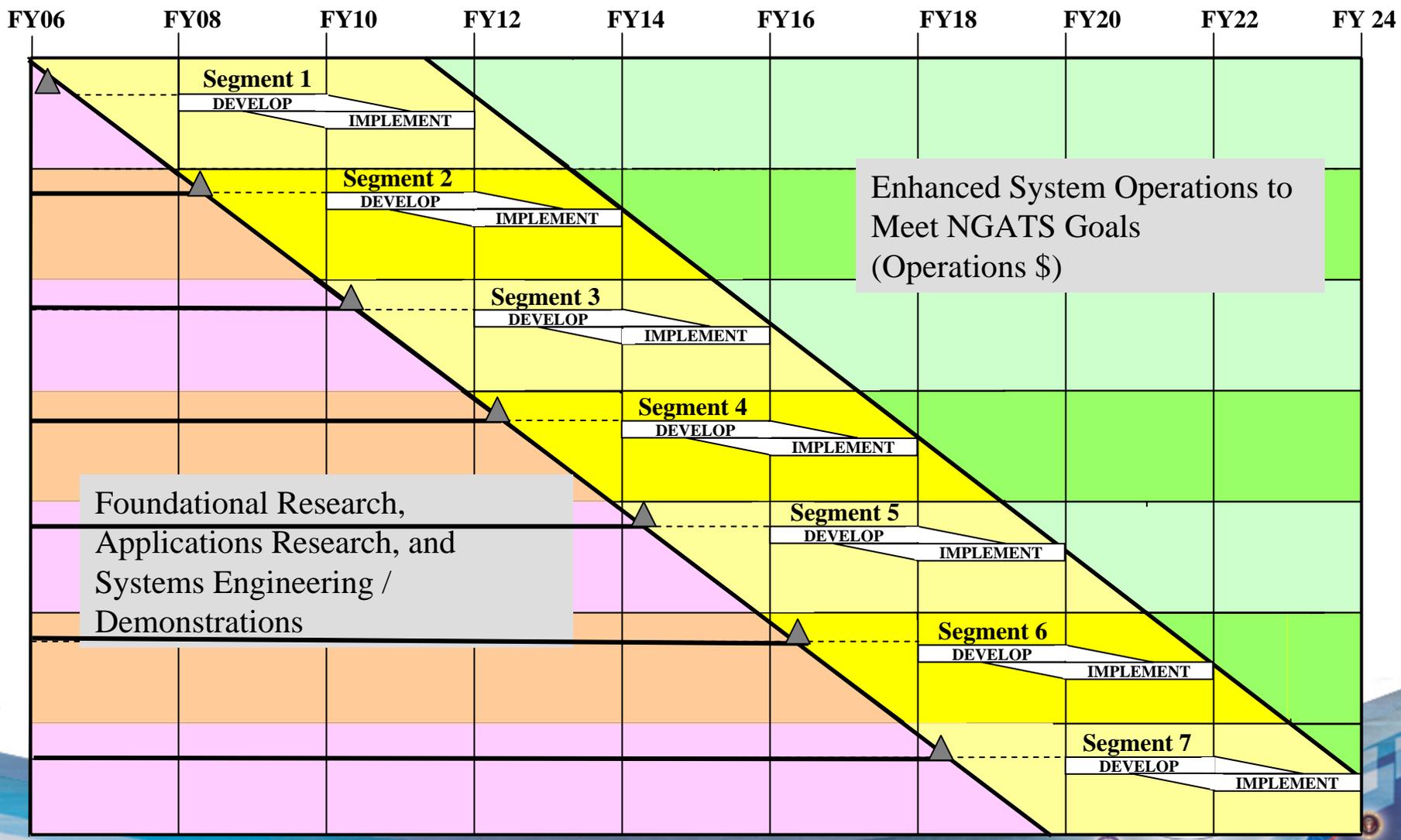
Review of Portfolio Capabilities

- Network Enabled Information
- Broad Area Precision Navigation
- Performance-Based Services
- Trajectory-Based Operations
- Weather
- Layered, Adaptive Security
- Equivalent Visual Operations
- Super-Density Operations



To date we have simulated parts of these capabilities

NGATS Portfolio Roadmap



Portfolio Analysis Overview

- We have estimated feasible throughput for the baseline scenario and NGATS Segments 3 and 7
- Feasible throughput is an estimate of how many flights could be scheduled and flown considering system capacity constraints
- For the baseline, airport capacities are based on 2004 Benchmarks (OEP) and other FAA data; en route capacities are represented by current sector MAP values
- Segments 3 and 7 airport capacities are estimated by Boeing modeling of the NGATS Operational Improvements
- For en route capacity, we assume Segment 3 MAP values increase by 15% and Segment 7 MAP values increase by 30%
 - In prior studies, CPDLC alone has shown 30% increase in sector capacity
- We model RNAV/RNP as reducing flight counts against MAP value
 - by 10% at 35 OEP airports in Segment 3
 - by 50% at top 100 airports in Segment 7

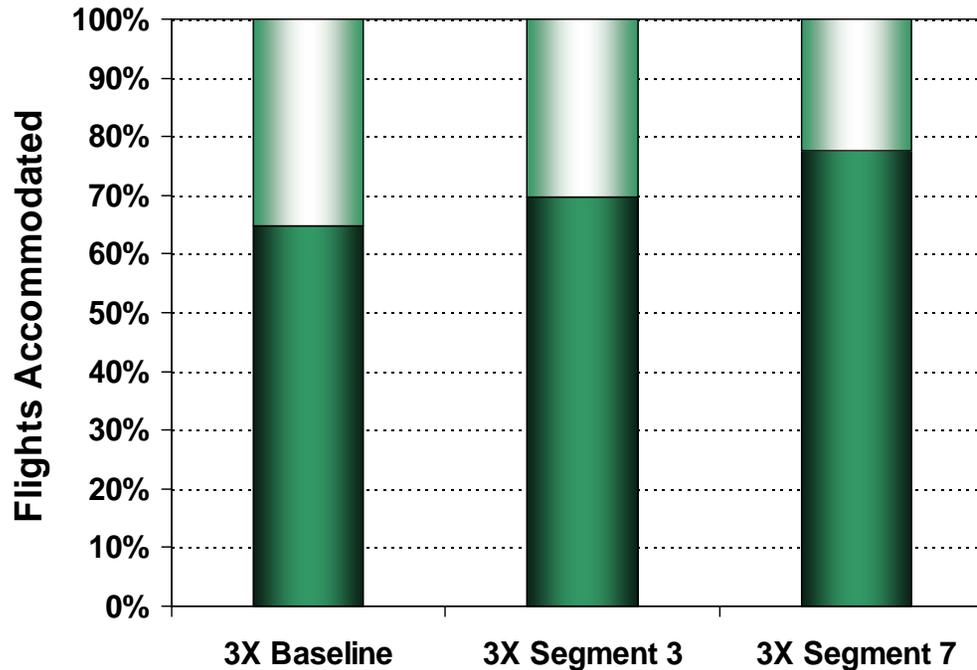
Portfolio Analysis Results

- Each scenario starts with 132,108 commercial flights (unconstrained 3X demand); there are 40,803 additional GA flights
- Each scenario assumes universally good weather (this is standard for estimating feasible throughput because airlines plan their schedules for good weather)

Scenario	Feasible Throughput (flights)	% of 3X Goal Achieved	Flights Eliminated (flights)	% of 3X Goal Shortfall
3X Demand, Baseline	85,513	64.7 %	46,595	35.3 %
3X Demand, Segment 3	92,116	69.7 %	39,992	30.3 %
3X Demand, Segment 7	102,583	77.7 %	29,525	22.3 %

Note: Statistics presented here exclude GA flights

Results Expressed as Success in Achieving 3X Goal



- Complete achievement of 3X goal = all flights accommodated (100%)
- Percentage of flights accommodated, as expected, increases as NGATS is developed