

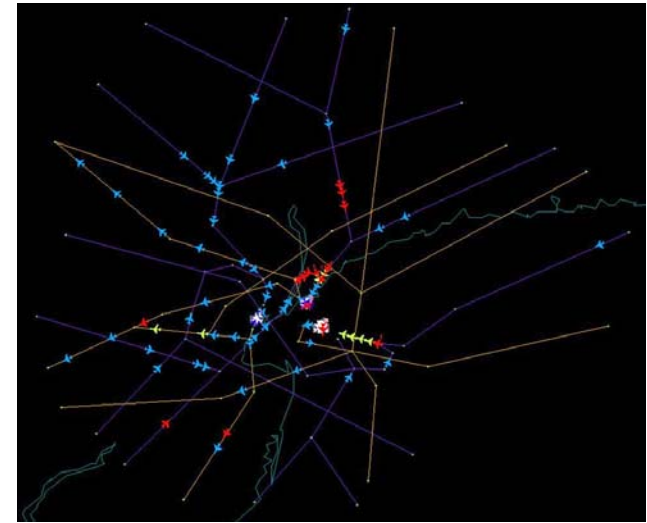
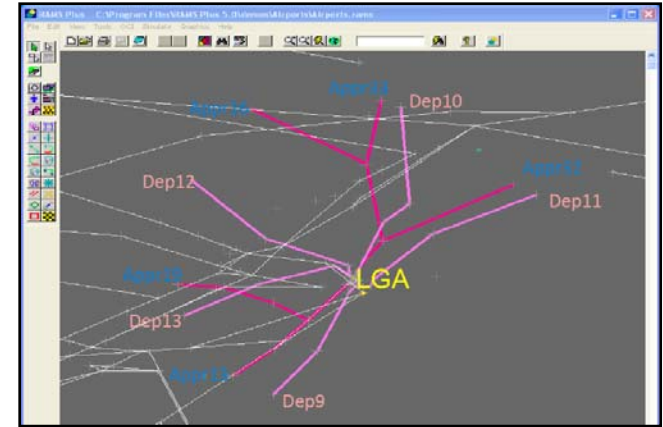
Modeling and Simulation Tools for NextGen: A Few Missing Links

NASUG Spring Meeting
March 12, 2009

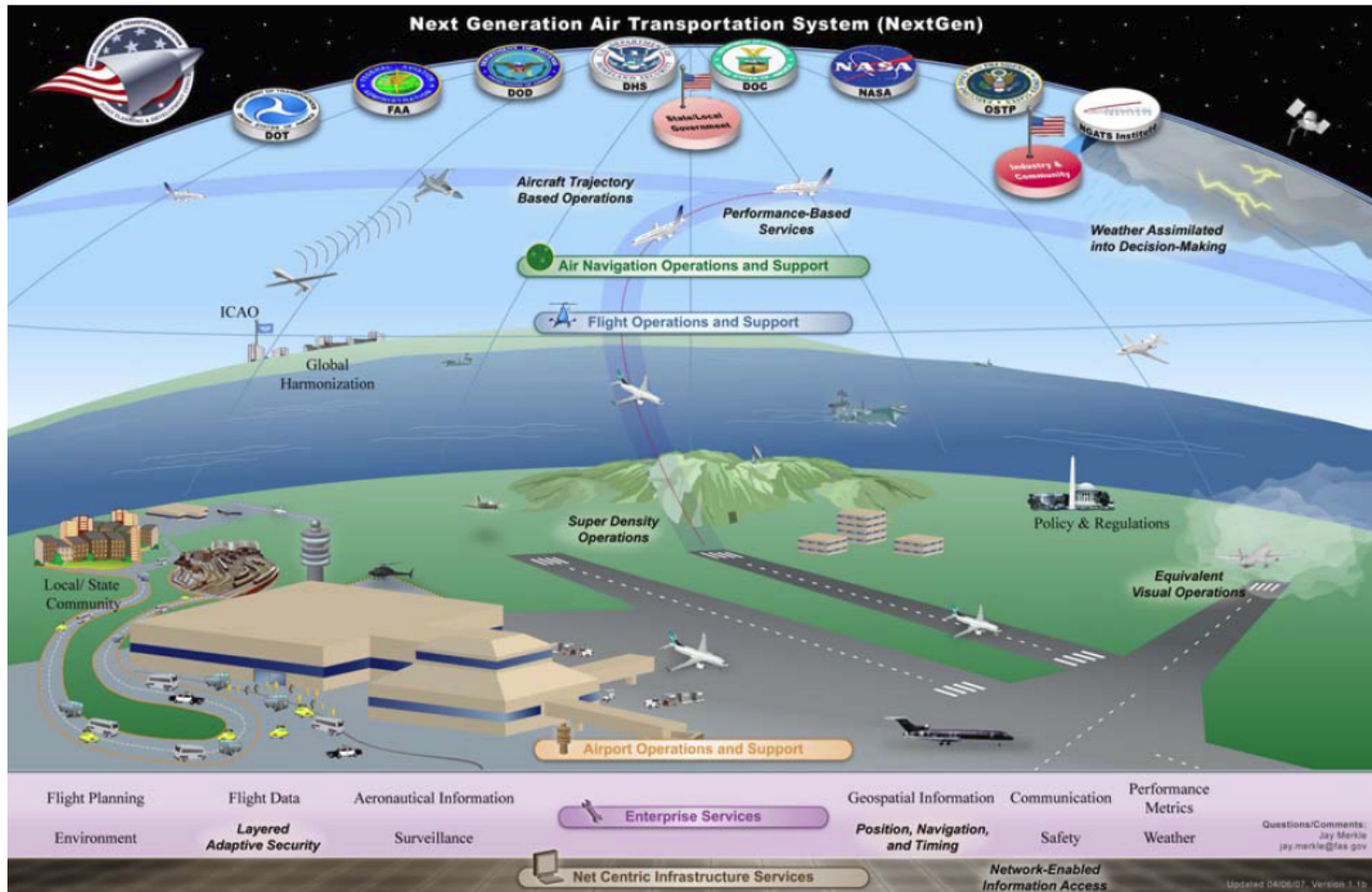
A.A. Trani

Introduction

- While a wide variety of tools and models are in use by government agencies to conduct airport and airspace studied,
- There are significant gaps left out by these tools to address the Next Generation Air Transportation System
- This presentation focuses on three important gaps identified



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)

Example Models Used in Capacity and Delay Analyses

| System Level | Apron/Taxiways | Runways and Close Airspace | Terminal Area | Enroute |
|---------------------------------|---|--|--|---|
| Macroscopic (Policy Analysis) | | LMI Runway REDIM FAA ACM DELAYS Boeing Runway Model AND | SDAT | SDAT |
| Mesoscopic (Traffic Flow) | | ACATS | NASPAC FACET LMINet systemWideModeler | NASPAC FACET AWSIM ACES LMINet systemWideModeler |
| Microscopic (Detailed Analysis) | SIMMOD Plus/Pro RAMS TAAM VTAsim | SIMMOD Plus/Pro RAMS TAAM ACE* | SIMMOD Plus/Pro RAMS TAAM ACES | SIMMOD Plus/Pro RAMS TAAM ACES |

Model Evaluation Form Information (what we collected)

- 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

Some Gaps in Current Models

(just a few to generate some discussion among the audience)

- **Wake vortex awareness procedures**
- Optimization for intelligent dynamic route changes (pilot or ATC driven)
- Procedures to model complex and adaptive Air Traffic Flow Management

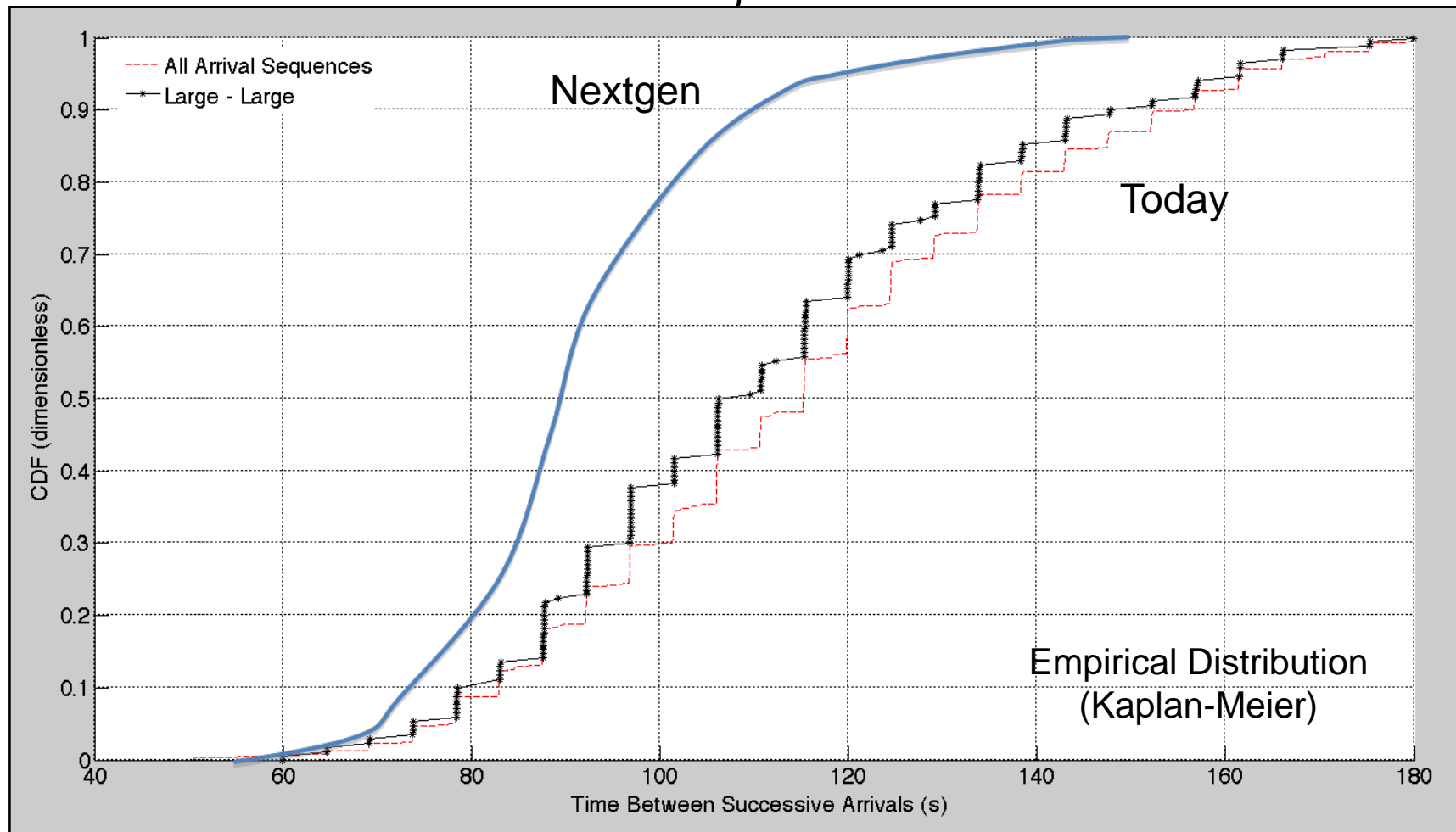
Wake Vortex Modeling in Simulation Models

- Most modelers, SIMMOD included, deal indirectly with the wake vortex problem
- Aircraft separation (time and distance) and runway blocking rules enforce equivalent “wake vortex” separations



Close parallel runway operations

Sample Cumulative Density Function of Arrival Headways (Input to airport/airspace models)

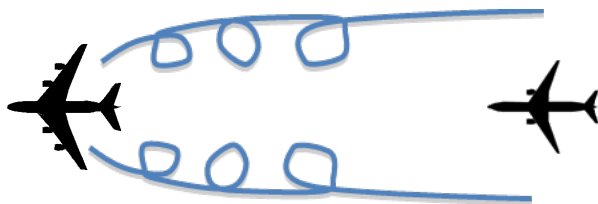


The Problem

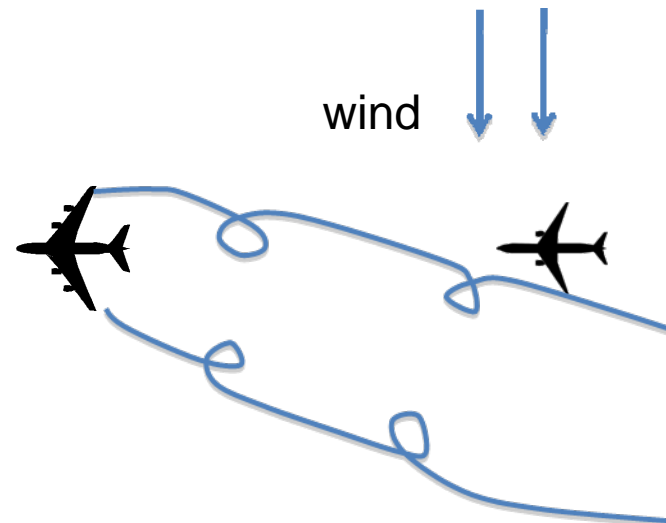
- NextGen promises to improve throughput capacity allowing closely-spaced runway separations and new procedures
- Airport terminal area transition airspace operations requires aircraft-pairs to be tracked for sensor separation and due to wake vortex
- Just like the real world

Wake Vortex Modeling

- A very dynamic problem
- Wake vortex envelopes are difficult to quantify
- NASA and European models exist to crudely assess the shape and vortex strength behind an aircraft



No wind



Wake Vortex Issues and Close Parallel Operations

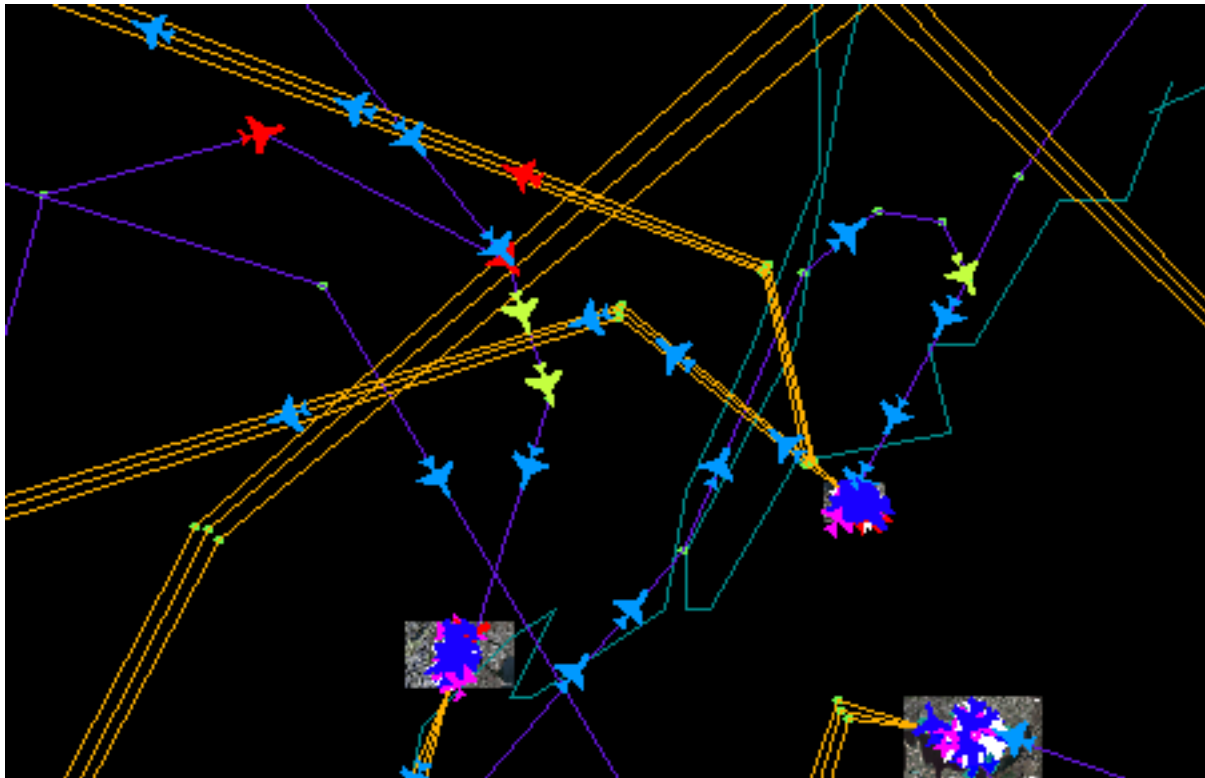
- One of the most promising techniques to increase capacity under NextGen is the use of closely spaced operations in all types of weather
- Current operations at St. Louis, SOIA operations in San Francisco and Cleveland represent precursors of the things to come
- Problem is that models will need to have the logic to “fly” such approaches more realistically



Simultaneous close parallel landing operations at LAX in VMC conditions

Transition Airspace

- As separation minima is reduced wake vortex interactions could become a significant factor in terminal area transition airspace



Dynamic Routing and Four Dimensional Trajectory Operations

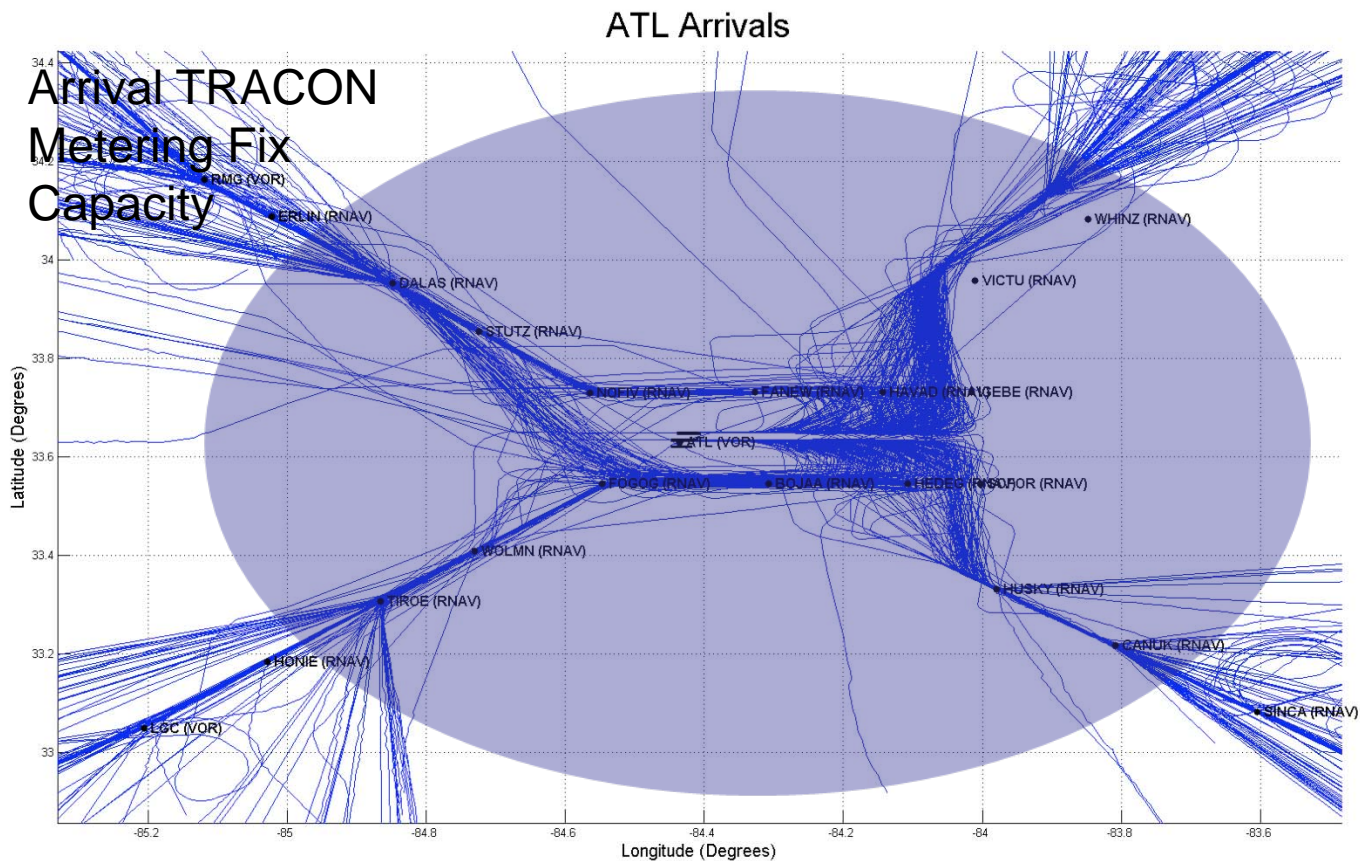
- Models will need to adjust vehicle performance to achieve 4D targets throughout the flight
- This is not a commonly available in most aviation simulation models reviewed



Airbus A340-300 landing at LAX runway 24R (directly over threshold)

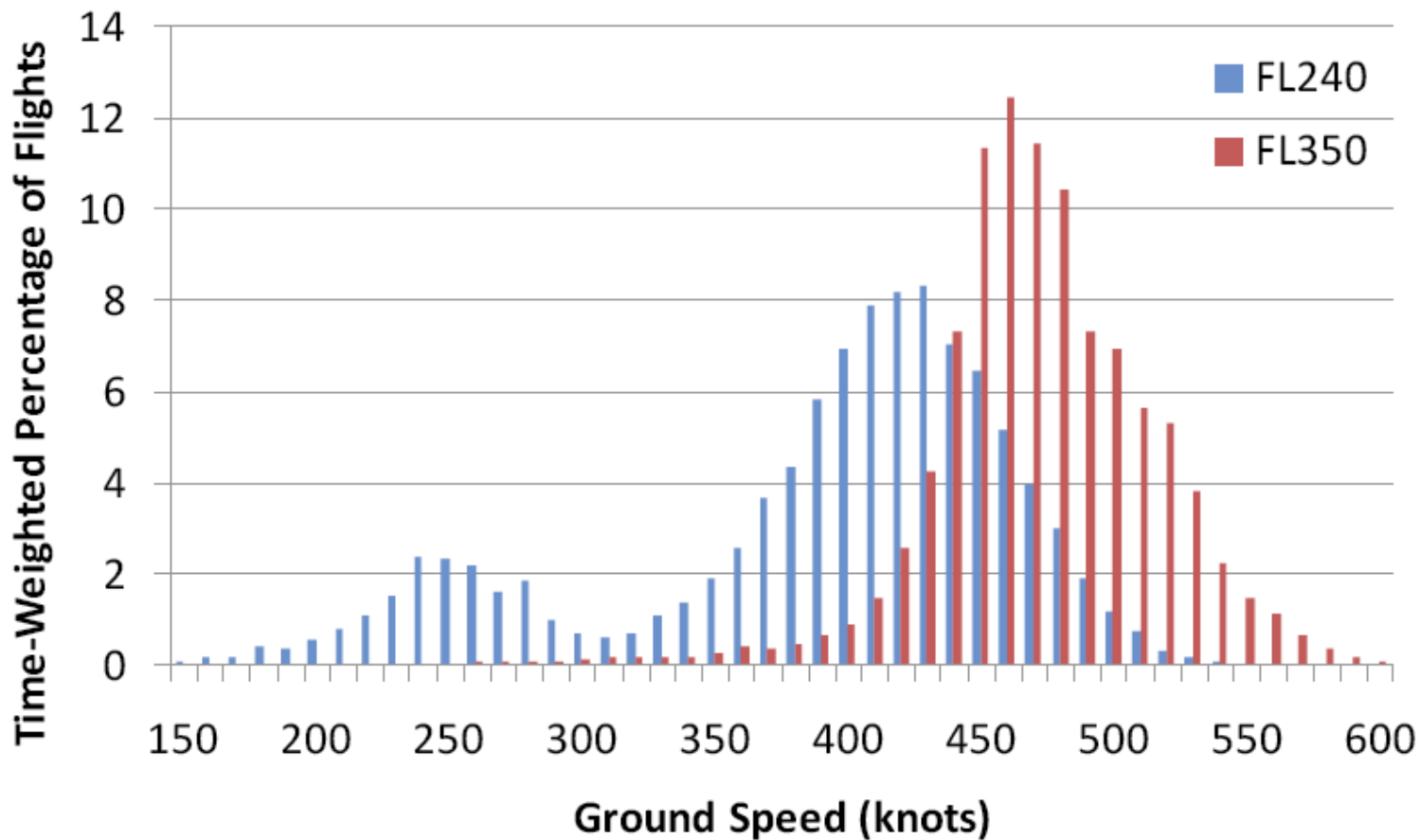
4D Trajectory Operations

- Many of the inefficiencies observed today in the terminal area tracks will be reduced



Complexity in the Airspace Due to Heterogeneous Aircraft Performance

Aircraft Performance by Altitude 08/29/2005



Challenges

- With NextGen the system is going to get more complicated
- Make aviation simulation models more aware of wake vortex and 4D trajectory based operations
- Improve the intelligence for models to make on-the-fly decisions about route changes (with minimal intervention)

Questions

Happening just across the river

