

A Probabilistic Modeling Foundation for Airport Surface Decision Support Tools

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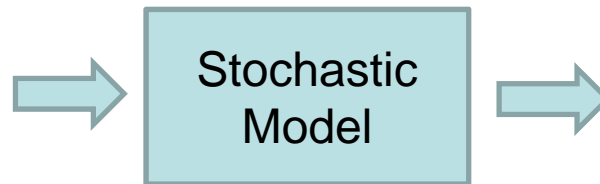
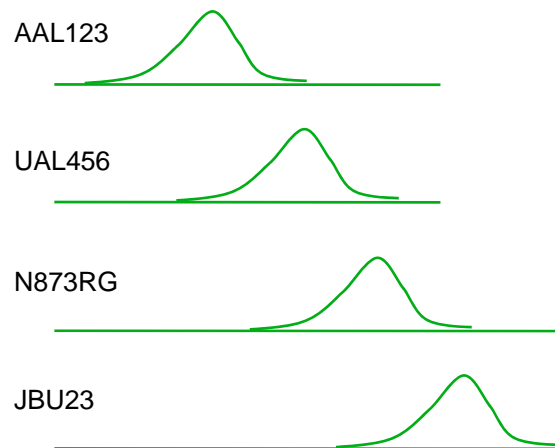
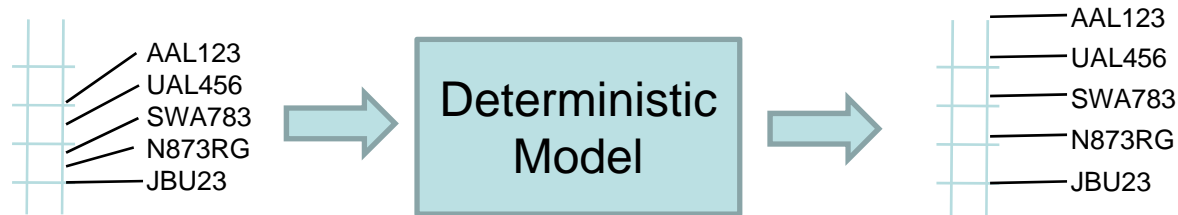
Presentation Outline

- Problem Background
- Stochastic Airport Planning Problem
- Dynamic Airport Planning Problem
- Impact of Uncertainty
- Stochastic Modeling Approach
- Conclusions and Next Steps

Problem Background

- NextGen Airport Surface Capabilities:
 - Surface Traffic Management
 - Surface Trajectory Based Operations
 - Departure Queue Management
 - Airport Configuration Management
 - Arrival/Departure Optimization
- Decision Support Tool Algorithms Commonly Use a Deterministic Approach
 - Assume Deterministic Inputs and a Deterministic Model
 - Results in a Brittle Decision Support System

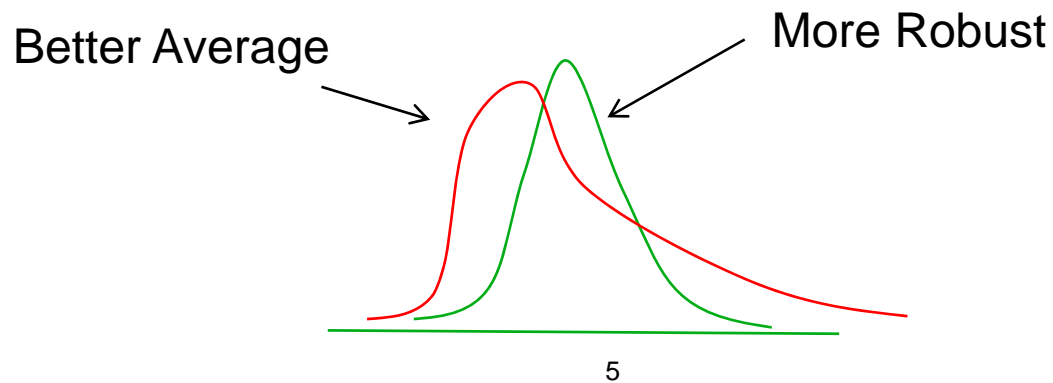
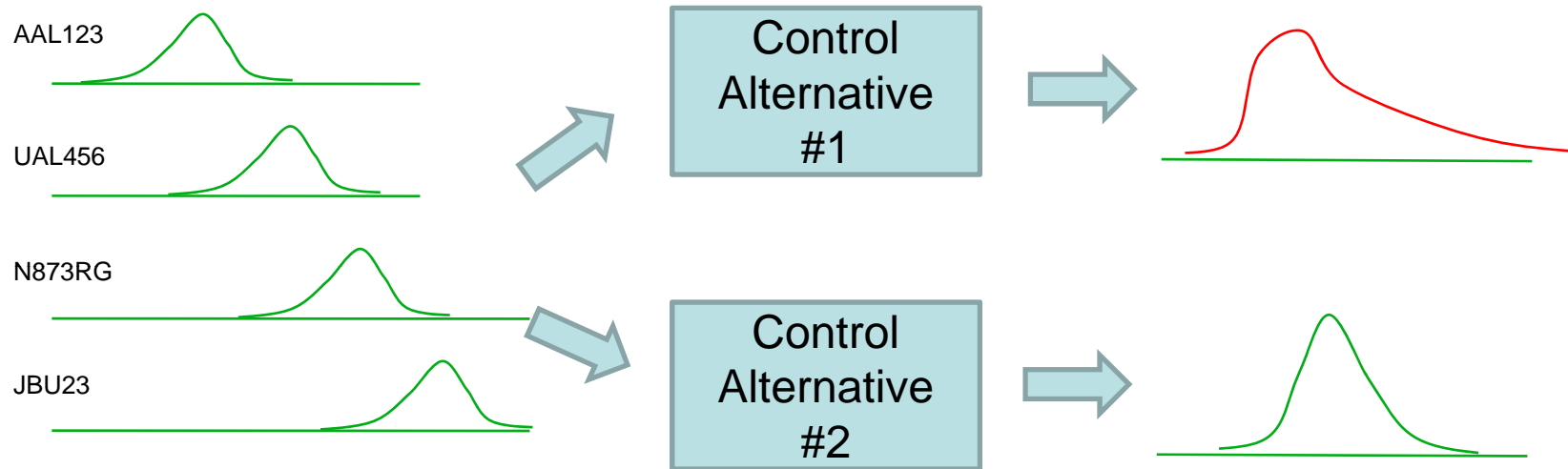
Stochastic Airport Planning Problem



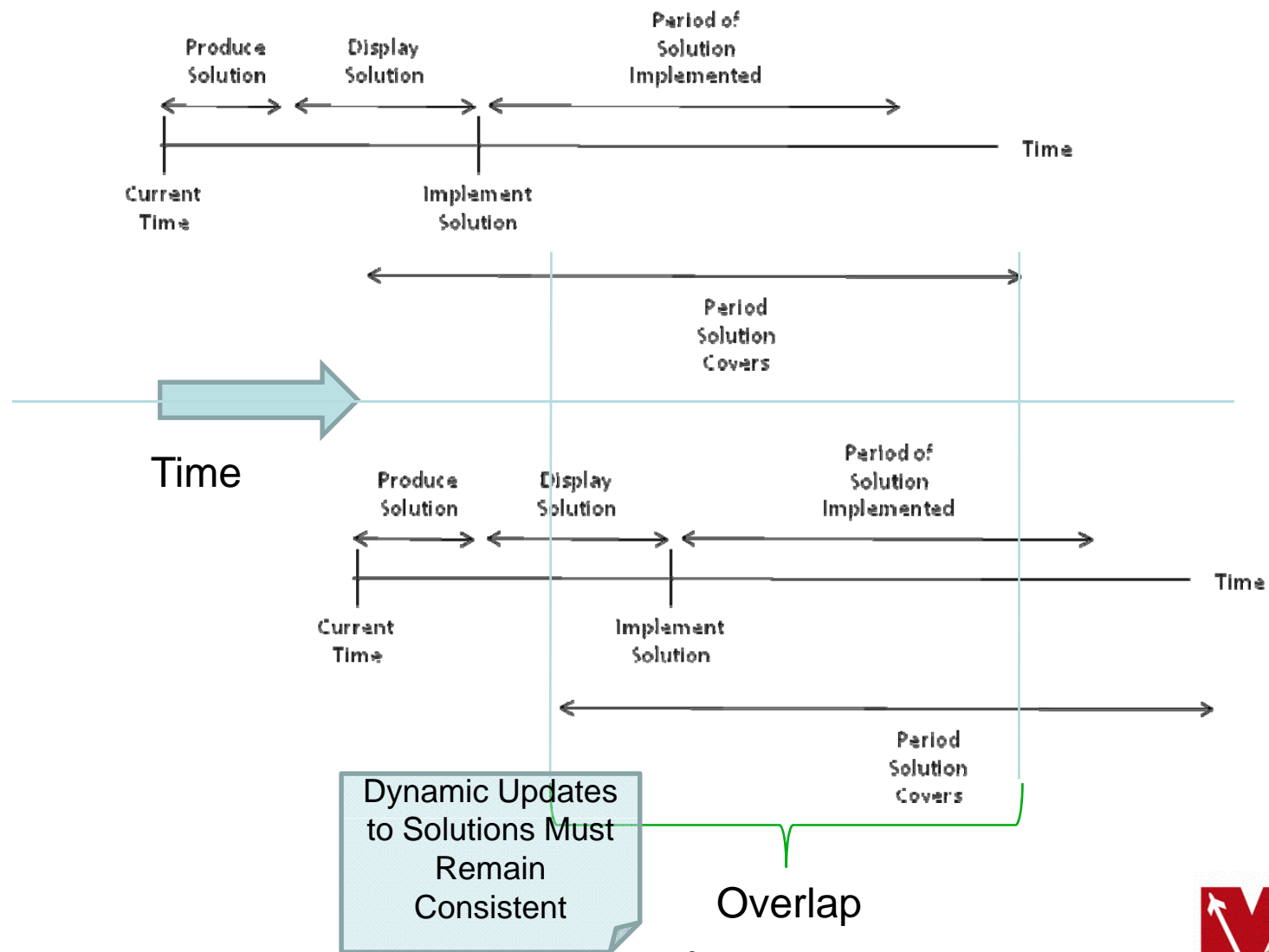
Output Metric:

- Delay
- Taxi Time
- Etc.

Stochastic Airport Planning Problem (cont.)



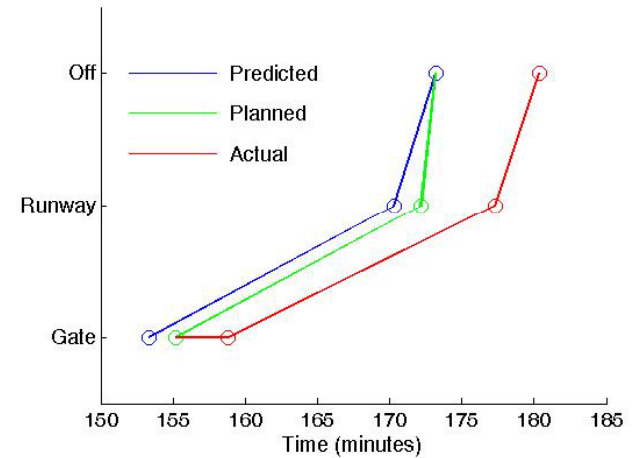
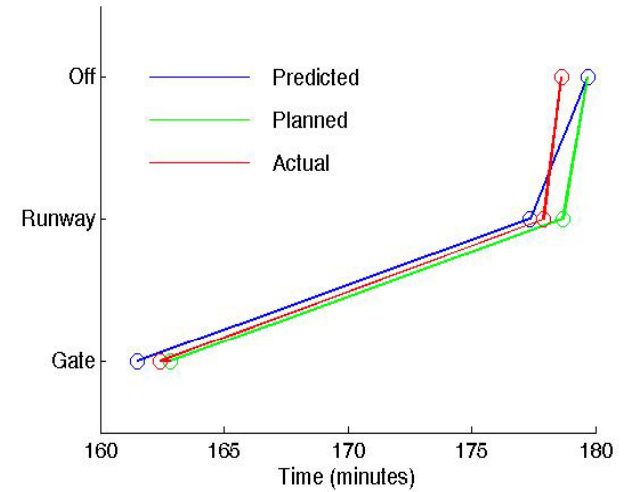
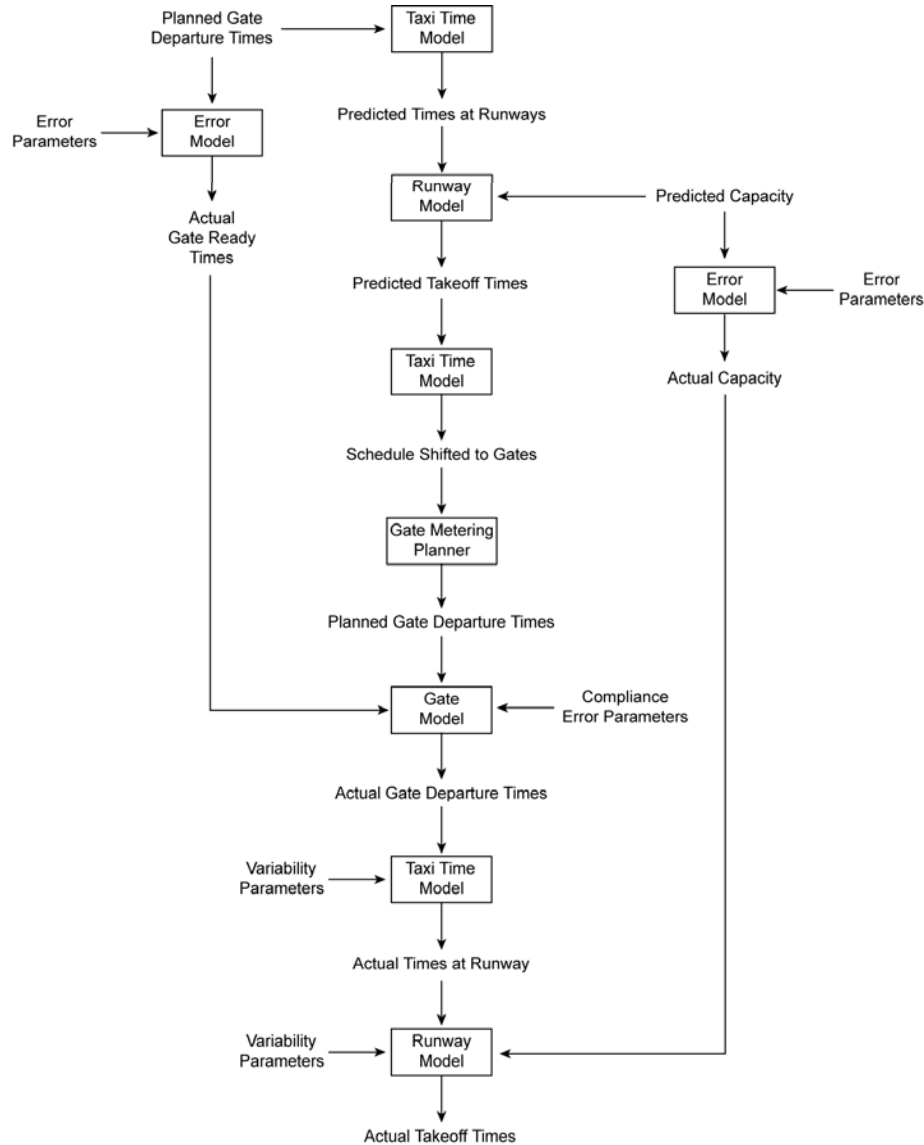
Dynamic Airport Planning Problem



Stochastic Dynamic Problem

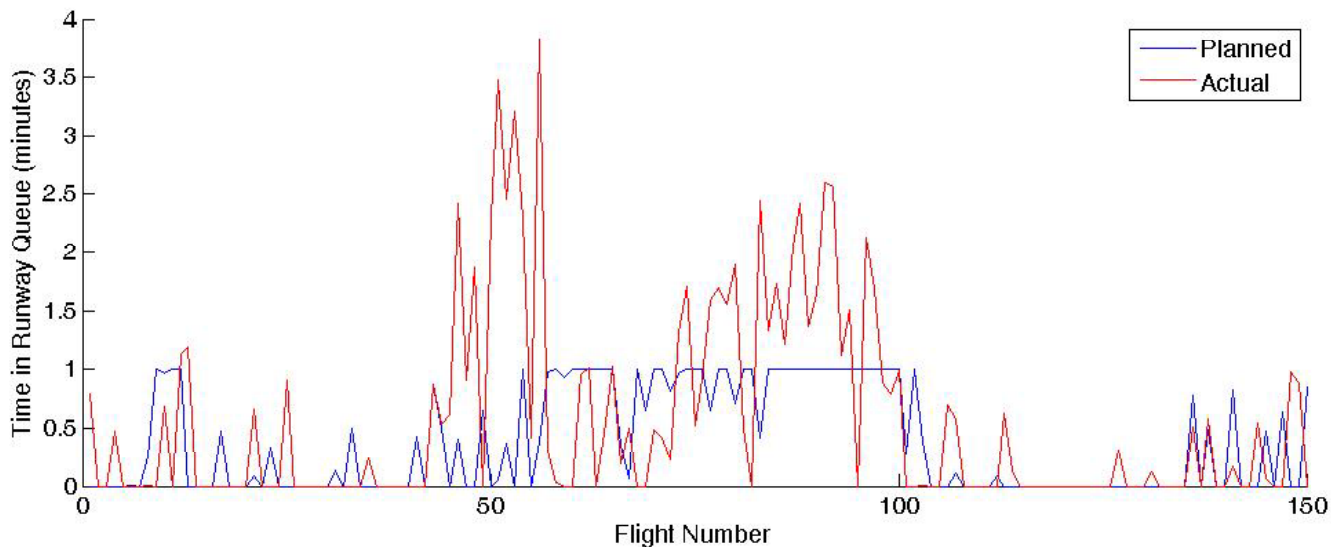
- Decision Support Systems Operate in Both Stochastic and Dynamic Environments
 - Both Aspects of the Problem Must be Considered for Success
- Consideration of the Stochastic Problem Supports Effective Solutions to the Dynamic Problem
 - In a Deterministic Dynamic Approach, Solution Instability Can be Caused by Uncertainty
 - By Using a Stochastic Approach, Greater Stability in the Dynamic Solution is a Side-Effect

Impact of Uncertainty – Queue Management

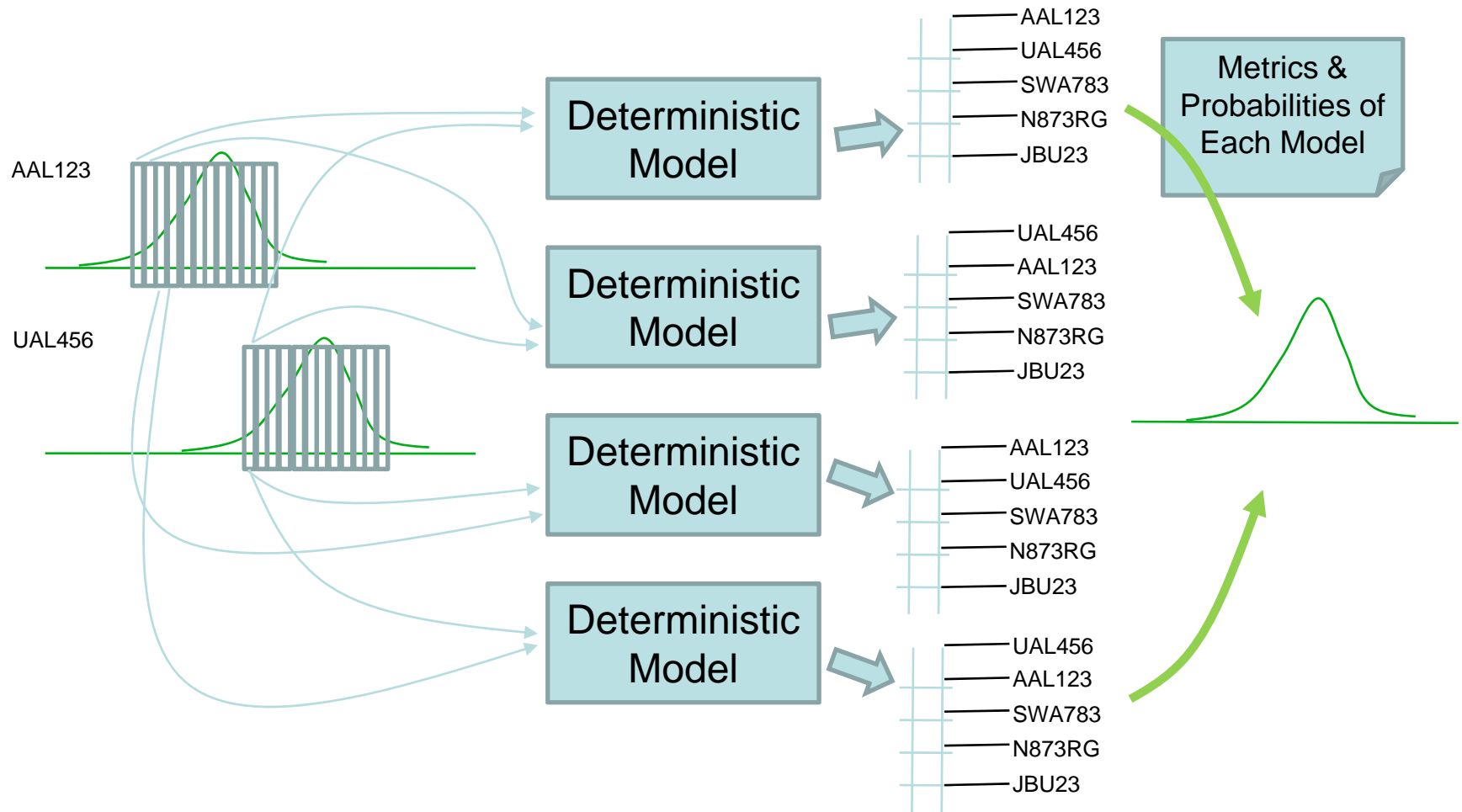


Impact of Uncertainty (cont.)

- Modeled Time in Runway Queue Demonstrating Impact of Uncertainty
 - On Average, Time in Runway Queue Increases
 - Reduces Benefit of Queue Management



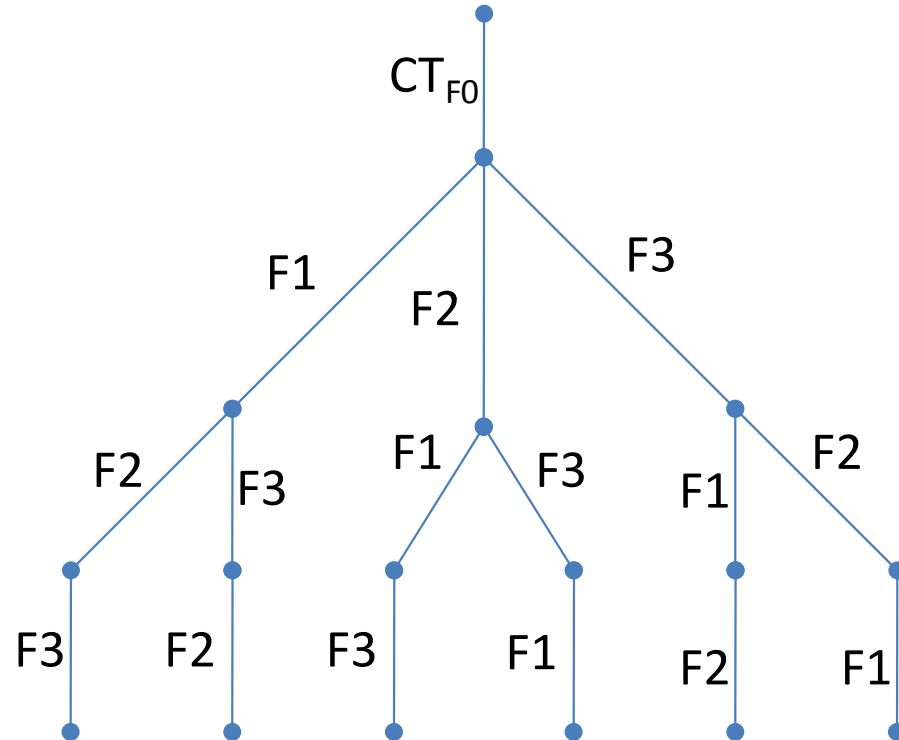
Stochastic Modeling Approach



Computation Complexity = (PDF Sample Points) ^ (# Flights)

Stochastic Modeling Approach (cont.)

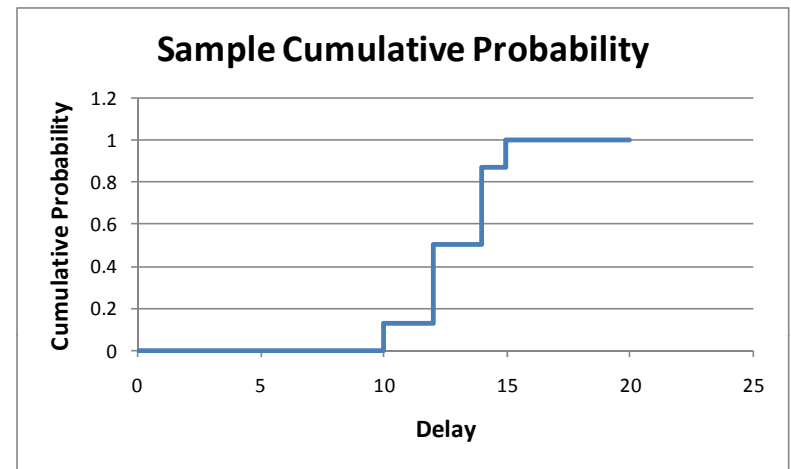
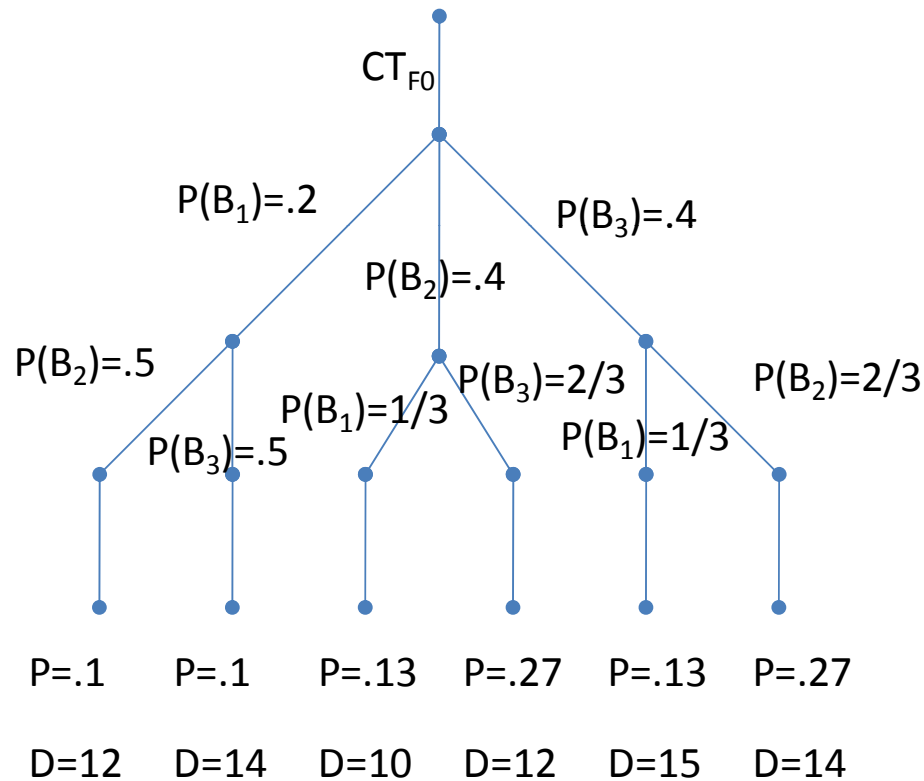
- Explicit Use of Stochastic Model
 - Consider Solution Dynamics Using Probabilities of Each Solution
- Evaluate PDFs to Determine Probability of Each Sequence
 - As the Sequence is Developed



Stochastic Modeling Approach (cont.)

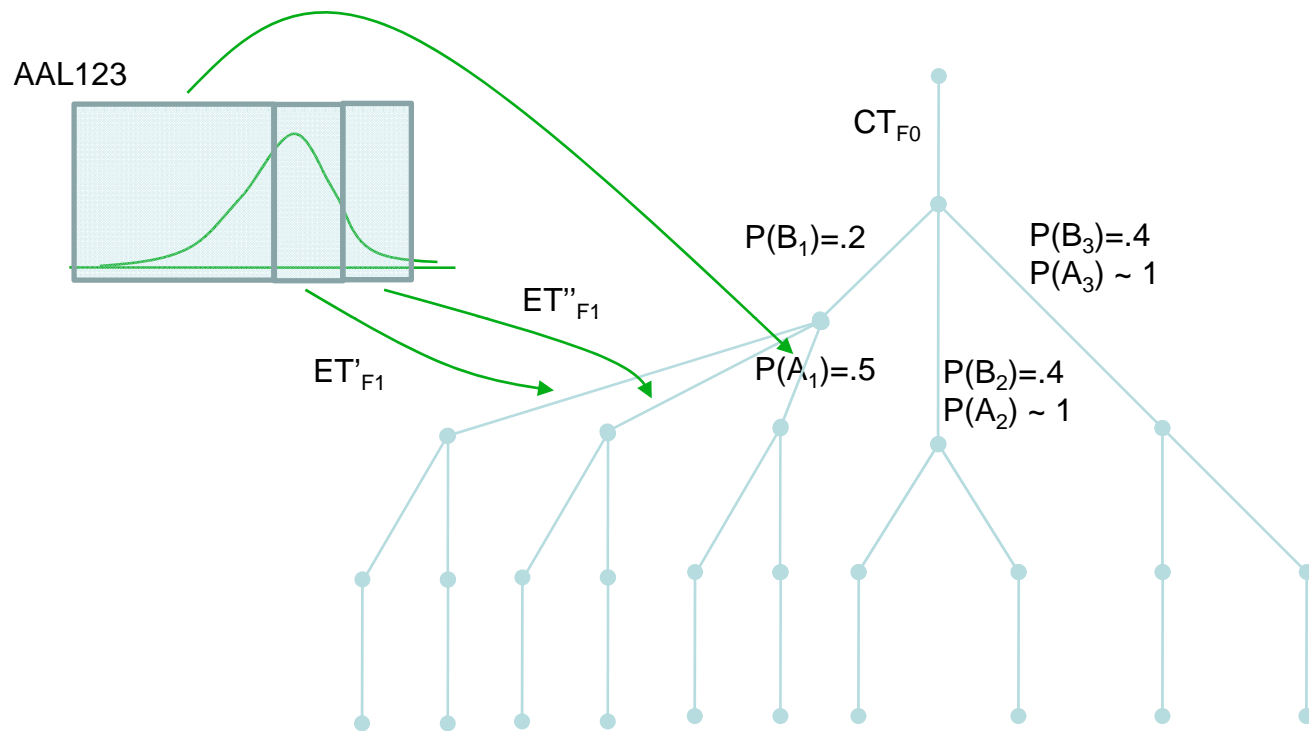
- Uncertainties Considered in Stochastic Modeling Approach
 - Likelihood of Flight i Being Available at Required Time
 - Event A_i $P(A_i) = \int_{-\infty}^{CT_{i-1} + RS_{i-1,i}} f_i(t) dt$
 - Likelihood of Flight i Being Next in Sequence
 - Event B_i
 - Likelihood of Overall Sequence
 - Event B_i Addresses Individual Sequencing Decisions
 - $P(\text{Seq}_k)$ Addresses the Overall Sequence
- Uncertainties Not Considered in Current Approach
 - Distribution of Separation Applied

Stochastic Modeling Approach (cont.)



This Example Assumes All $P(A_i) \sim 1$

Stochastic Modeling Approach (cont.)



Conclusions and Next Steps

- Both the Stochastic and Dynamic Aspect of the Real World Must be Considered to Create a Successful Decision Support Capability
- A Stochastic Modeling Framework for Airport Surface Decision Support Algorithms has been Described
- Implementation of this Approach is Underway
- Results will be Described in Future Publications