Air Traffic Planning in an Uncertain World

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Problem

- Air traffic planning decisions are based on imperfect predictions of traffic demand and capacity, but uncertainties are not known.
  - This produces large-scale, conservative control actions, leading to excess delays and unused capacity.
- By taking uncertainty explicitly into account, can we improve decision making?
  - Make the right decision at the right time?
  - Recommend precise corrective actions?

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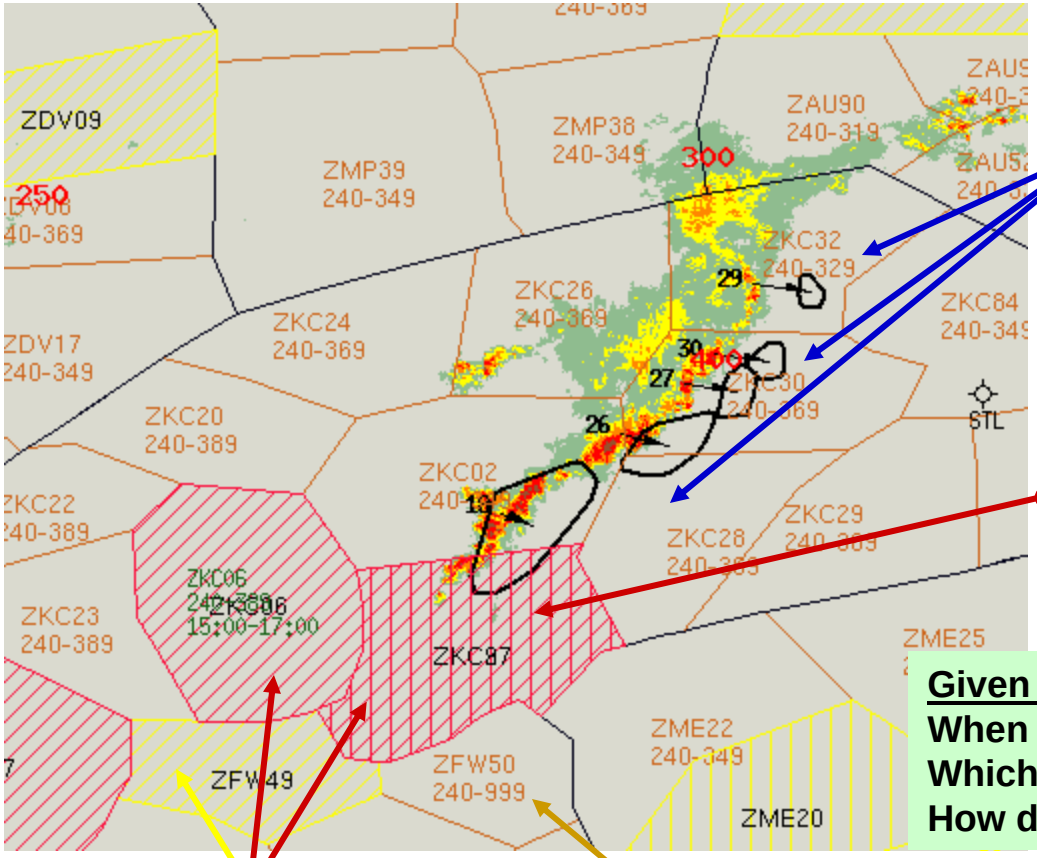
Background



Uncertain weather forecasts indicate future loss of airspace capacity…

Uncertain traffic forecasts provide airspace demand…

If demand exceeds capacity, delays will occur and safety may be compromised.

Given the uncertainty:
When should air traffic be restricted?
Which flights should be affected?
How do flight operators participate?

Congestion Alerts

Air traffic control sector

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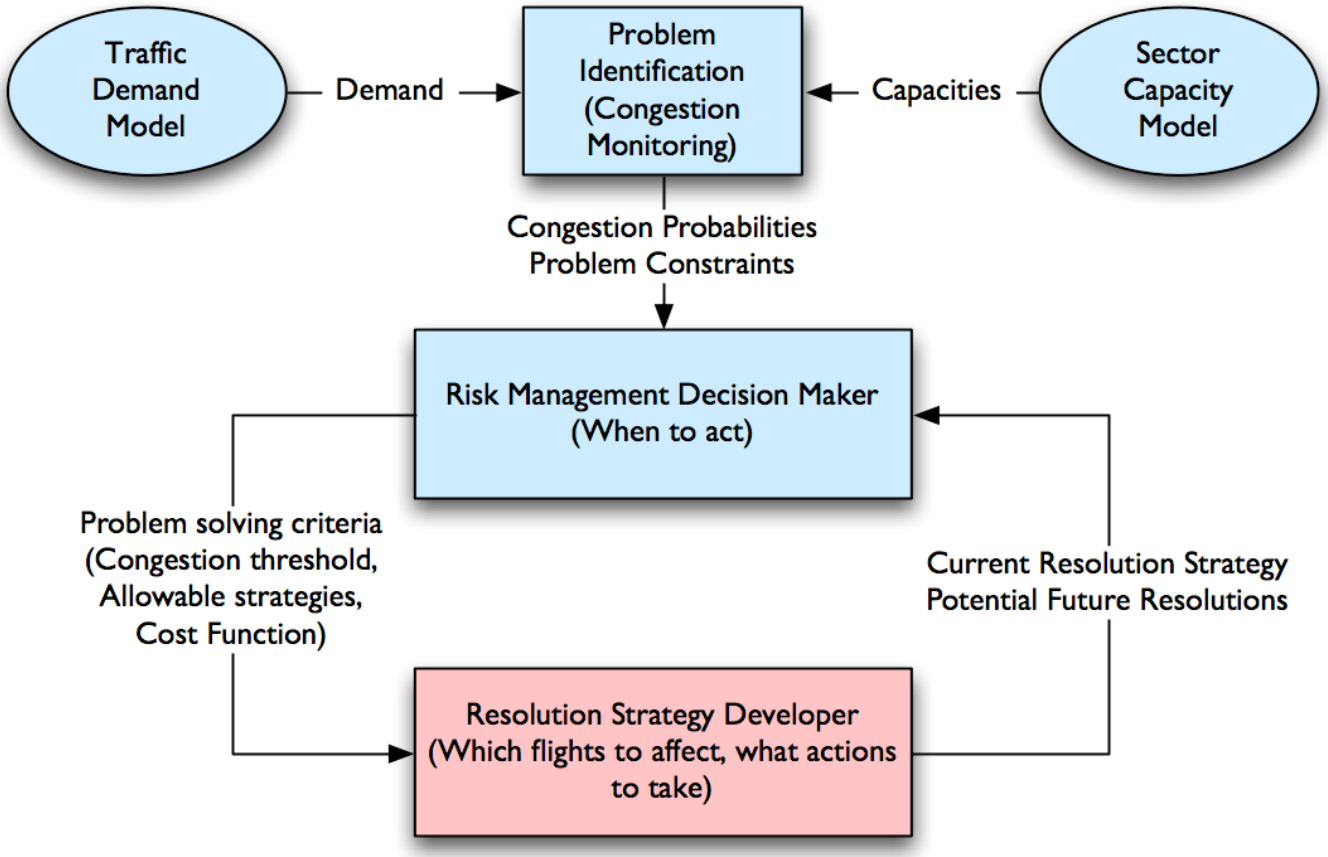
Objective

- **Develop incremental, probabilistic methods for solving congestion with minimum impact**



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Activities

- Testing algorithms for incremental decision making (DM) and resolution development
  - Monte Carlo simulation of incremental DM
  - Hybrid, multi-objective genetic algorithm for optimal congestion resolution actions
- Adapting algorithms for operational use, and estimating the benefits of their use
- Developing models to predict air traffic sector capacity in the presence of weather

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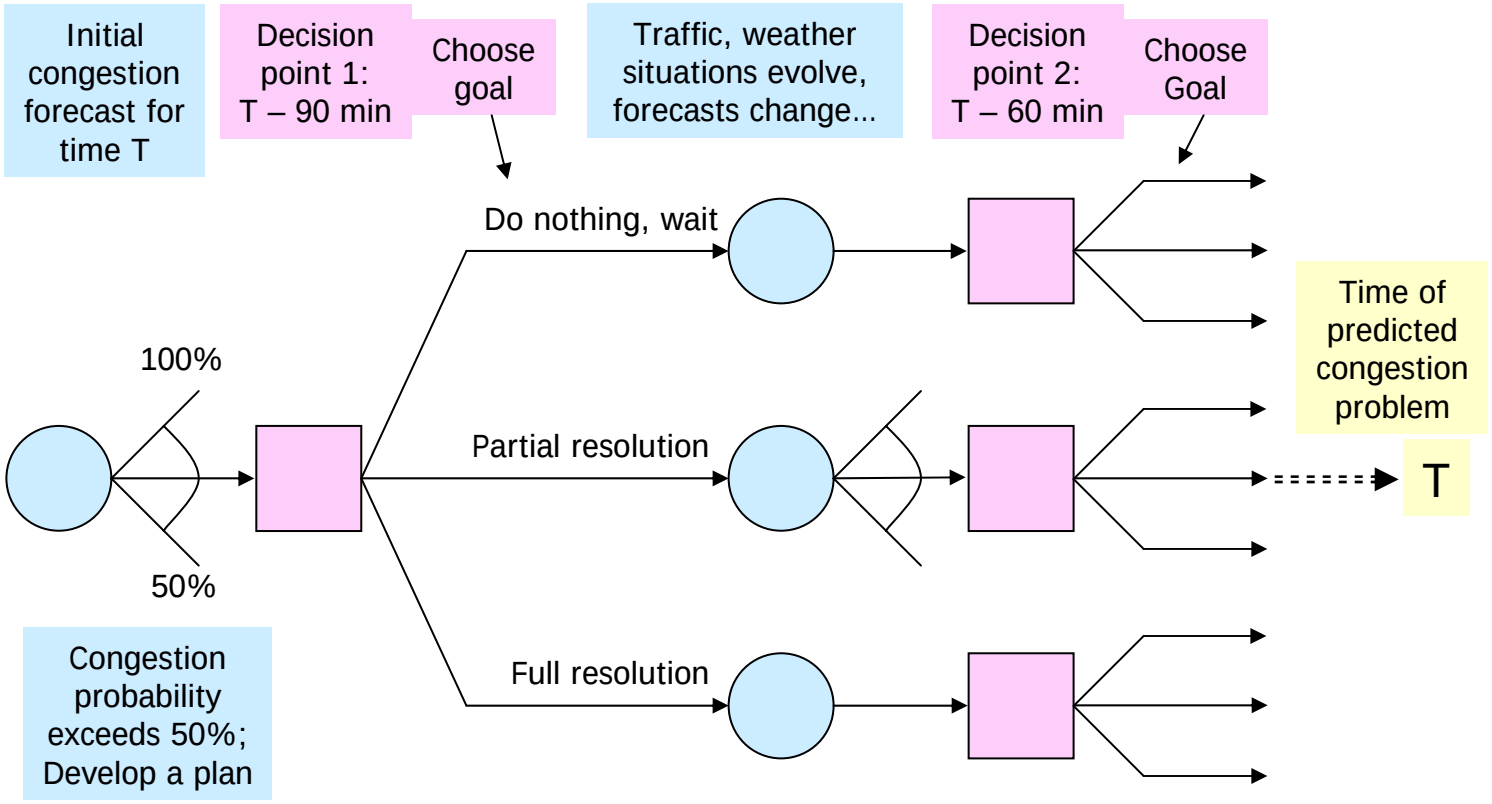
Highlight

Incremental Decision Making



Of the possible decision paths, which one reaches the congestion management goal with the least operational impact?

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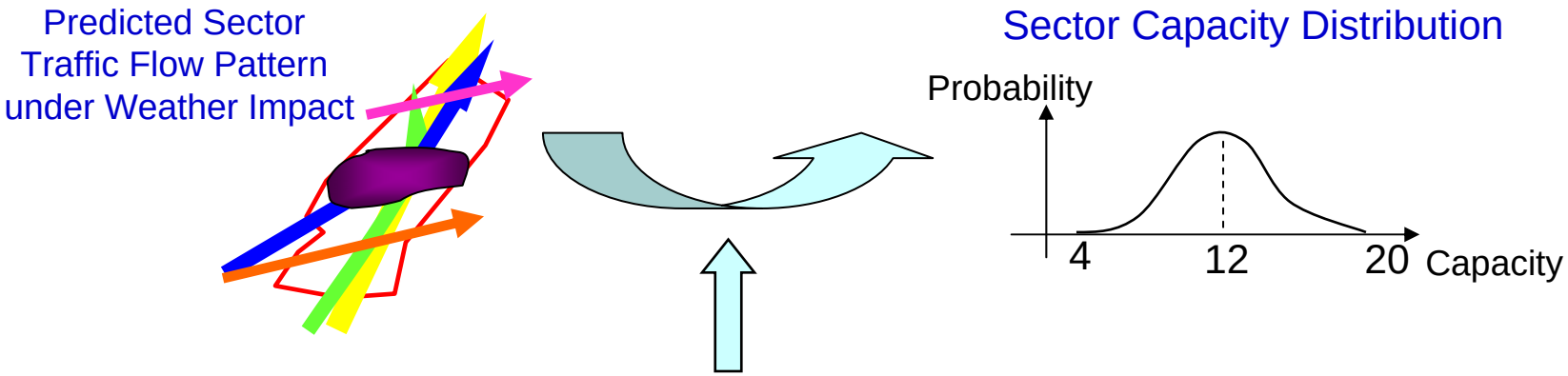
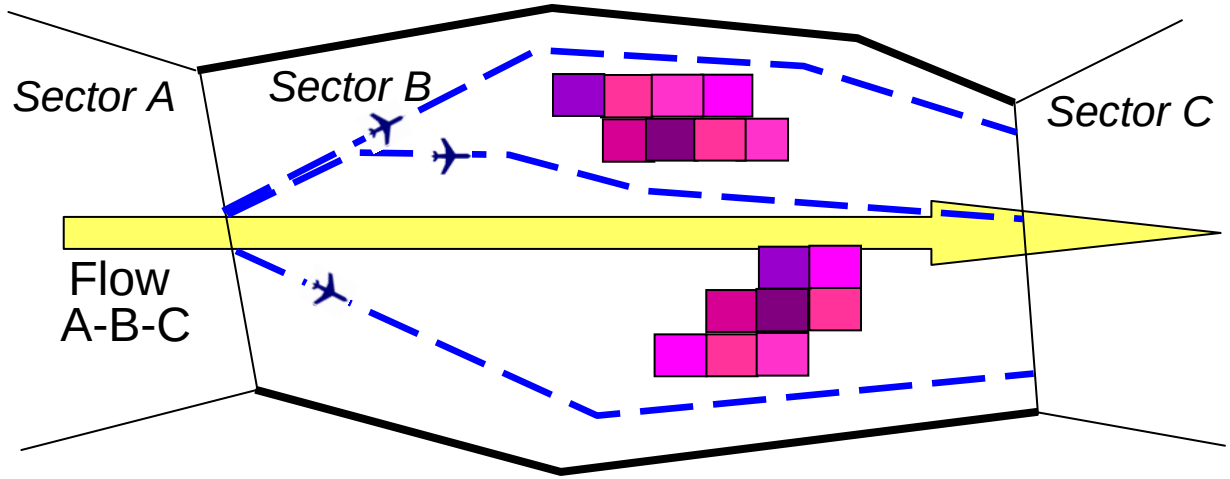
Highlight

Predicting Sector Capacity Under Severe Weather Impact



Flow Capacity Distribution Given Probabilistic Weather Avoidance Field



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Impacts

- Foundational research for the NextGen Air Transportation System, a major initiative
  - Better tactical congestion management means a more robust and flexible air transportation system.
  - Lessons learned in the analysis can be applied today as decision rules.
- The modeling methods developed here have applications to policy and benefits analysis
  - What is the benefit of investing to reduce uncertainty, such as for improved surveillance or weather forecasts?

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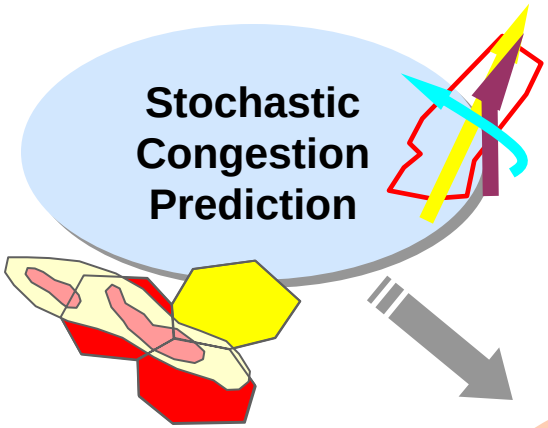
Future Plans

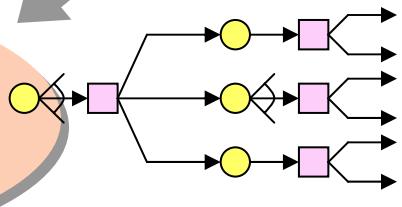
Stochastic Congestion Prediction



Resolution Strategy Algorithms

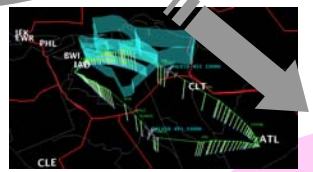
Monte Carlo Traffic Modeling

Incremental Decision Making Simulation and Analysis



Operational Benefits Analysis

Near-Term Congestion Resolution Procedures



Basis for Future Trajectory-Based Planning Systems

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