MEFISTO

Modeling of Environmental Factors in Surface/Terminal Traffic Optimization

New Project – October 2007

Dr. Terry Thompson (PI, Metron)
Dr. John-Paul Clarke (Co-I, GaTech)
Dr. Lance Sherry (Co-I, GMU)

NRA Topic AP-1: Modeling of Environmental Constraints in Surface Traffic Optimization
Motivation

• Significant increases in capacity sought for NextGen.

• Environmental constraints likely to increase with regard to noise, fuel efficiency, and local/regional air quality.

• Optimization of surface/terminal operations will become multi-objective problem.

• How will environment be factored into surface/terminal planning?
Overview

NGATS Airportal OpsCon Elements

Environmental Goals and Metrics

Baseline and Alternative Scenarios

Analysis of Environmental Constraints and Mitigation Options

High-Payoff Mitigation Options and Constraints

Baseline Surface Planner Functions

TASK 1

Report on Current and Future Environmental Constraints (Outcome O1)

TASK 3

Design of Environmental and Surface Planner (includes design iterations)

Requirements and Initial Design for Environmental Module of Surface Planner (Outcomes O2 and O4)

Techniques for Computation and Advice to Path Planner (Outcome O3)

Feasibility Demonstration (Outcome O5)

TASK 2

Clean-sheet Design and Benefits Analysis

Revised Mitigation Options

Report on Possible Noise and Emissions Reductions Using Clean-sheet Approach (Outcome O6)
Outcomes

O1. Report on characterization of environmental constraints in both current and future surface/terminal air traffic operations (FY2008)

O2. Develop concepts and requirements for environmental planner and interfaces with NASA surface simulation tools (FY2008)

O3. Identify/develop techniques to analyze noise/emissions output in near real-time based on data from recent flights, and develop techniques to advise the surface path planner on individual (or ensemble) constraints to mitigate critical noise and emissions issues (FY2008)

O4. Develop software interface requirements between the environmental planner and the surface path planner (FY2008)

O5. Demonstrate feasibility of proposed solutions (FY2009)

O6. Report on results of study to determine noise/emissions reductions possible for a given airport runway configuration using a clean-sheet-of-paper approach to taxiway and gate-area design, and unconventional operational or procedural concepts (FY2009)
Task 1 – Analysis of Environmental Constraints and Mitigation Options

- Literature review (supports all tasks)
- Scenario review and augmentation
- Goals and metrics review
- Fuel, emissions, and noise modeling
- Sensitivites and mitigation
- Tradeoff analysis
- Mitigation workshops
Task 2 – Clean-sheet Design and Benefits Analysis

- Representative models of current airports
- Model of optimum terminal and airside layout
- Comparative analysis of optimum and actual airports

NGATS Airportal OpsCon Elements

Baseline and Alternative Scenarios

Optimum Airport and Terminal Modeling

Current Airport and Terminal Modeling

Comparative Analysis

• Representative models of current airports

• Model of optimum terminal and airside layout

• Comparative analysis of optimum and actual airports

Revised Mitigation Options (to Task 3)

Report on Possible Noise and Emissions Reductions Using Clean-sheet Approach (Outcome O6)
Task 3 – Design of Environmental and Surface Planner

- Surface planner concept analysis
- Correlation of mitigation options with planner tasks
- Goals and metrics review
- Decomposition of options into goals and constraints
- Module design
- Development of prototype

NGATS Airportal OpsCon Elements

Baseline Surface Planner Concept

Surface Planner Concept Analysis

Baseline Surface Planning Tasks and Scope

Correlate Mitigation Options with Planning Tasks

Decompose Mitigation Options into Goals and Constraints for Planning Tasks

Environmental Module Design and Initial Prototype Development

- Requirements and Initial Design for Environmental Module of Surface Planner (Outcomes O2 and O4)
- Techniques for Computation and Advice to Path Planner (Outcome O3)
- Feasibility Demonstration (Outcome O5)

High-Payoff Mitigation Options (from Task 1)

Revised Mitigation Options (from Task 2)

Initial Surface Planner Functionality (from NASA surface simulations)
Coordination with Other Projects

• Current projects

  - Core NASA research on optimization (surface, terminal, …)
  
  - NRA AP-2: Surface Traffic Optimization in the Presence of Uncertainties (Clarke, GaTech)
  
  - NRA AP-2: Integrated Approaches for Surface Traffic Optimization in the Presence of Uncertainties (Wei, San Jose State)
  
  - NRA AP-3: Integrated Analysis of Airportal Capacity and Environmental Constraints (LMI, Metron)
  
  - NRA AS-20: Metroplex Design (3 teams)
  
  - JPDO System Modeling and Analysis
  
  - Others TBD

• Upcoming projects

  - ATCSCC mitigation analysis
  
  - Others TBD
Surface Optimization Research Project (AP-2)

**Purpose:**

1) analyze and baseline today’s surface operations;
2) develop a system architecture of optimization processes based on assumptions made for future surface operations;
3) formulate optimization problems; and
4) evaluate the feasibility and performance of proposed solutions.

**Scope:**

Airport configuration planning, departure scheduling, and taxi-route planning are some examples.

Robust against uncertainties: pushback time, pilot conformance to 4D taxi clearances, aircraft performance, surveillance data, estimated arrival time, and runway exit time.

Major hub airport surface should be modeled for current-and future demand schedule data.

Assess sensitivity of outputs to choice of objective function (e.g., throughput, delays, variance from desired airline schedules).
Candidate Airport Partners

• Port Authority of New York and New Jersey (LGA, JFK, EWR)
• Metropolitan Washington Airport Authority (IAD, DCA)
• San Francisco (SFO)
• Others?
European Perspectives

• Zurich (e.g., A-CDM, ZEUS)
• Frankfurt
• London Heathrow
• Amsterdam Schiphol (e.g., DHL EMS)
• Eurocontrol
• DLR
Envisioned Technology Evolution

Controllable Features and Environmental Effects

Interaction of Planning Factors and Probable Environmental Impacts

Equity and Efficiency Issues in Resource Allocation

Environmental Planner Logic and Design

Initial EP Module Prototype

JPDO/SMAD
EPACT
NASEIM
GreenSim
MEANS
CDA analysis

AMITIE

Interaction

DNAP
TOTE (TaxiOff Time Estimator)
ENTIRE
Surface Network Planner
ROMA
SMS/DFM

CDM
GDP/AFP
FSM and alloc. algs.
Key Scoping Questions

• What is the domain of action of the surface path planner (SPP)?

• What are the objectives of the SPP? What are supporting objective functions?

• What are highest-payoff options for the SPP, from an operational point of view?

• What is the role of the environmental planner (EP) vis-a-vis the SPP?

• Others TBD
Workshop One (~February 2008)

- Environmental mitigation/control in the context of optimization of surface/terminal operations.

- Identify key R&D issues, constraints, priorities...

- Draft agenda:
  - Surface optimization scope, assumptions, and techniques
  - Environmental metrics and goals
  - Environmental trade-offs: noise, emissions, fuel
  - Linkages and trade-offs between operational and environmental goals
  - Concepts for functional architecture