Overview of the Air Transportation Laboratory

18 May 2010
Overview

Mission
Motivation
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Research Projects
ATL Mission

Enable the future of air transportation by simultaneously...

- Maximizing efficiency
- Maximizing positive societal impact
- Minimize negative societal impact (especially on the environment)

Through innovations in...

- Control
- Human Factors
- Optimization
- System Analysis and Design
ATL Mission (alternate definition)

Creating the future…

- one algorithm
- one airline schedule
- one flight procedure

at a time by…

- Combining theory and practice
- Accelerating industry adoption
- Training future industry thought-leaders
- Training next generation of researchers
ATL Motivation

Air transportation in the School of Aerospace Engineering (AE)

- Critical mass recently created in air transportation
  - Through hires (Clarke, Feigh, Feron) and transfers (Pritchett)
- Opportunity to address the “entire system”
  - Interactions between vehicle design and system design and operations

Air transportation related courses and research in other schools

- Industrial and Systems Engineering (ISyE)
  - Airline scheduling and in large-scale optimization
- Electrical and Computer Engineering (ECE)
  - Game theory
- Mechanical Engineering (ME)
  - Modeling and open-loop control
- Civil and Environmental Engineering
  - Demand modeling

Opportunity to create focused initiative across Institute
ATL People

Faculty

- Barnes (Morgan State University)
- John-Paul Clarke (AE)
  - Director
- Ozlem Ergun (ISyE)
- Karen Feigh (AE)
- Eric Feron (AE)
- Laurie Garrow (CEE)
- Ellis Johnson (ISyE)
- Amy Pritchett (AE)
- Jeff Shamma (ECE)
- William Singhose (ME)
- Senay Solak (U Mass Amherst)

Research Engineers

- Jim Brooks (AE)
- Hui-Han Chang Chien (AE)
- Atri Dutta (AE)
- Leihong Li (AE)
- Terran Melconian (AE)
- Liling Ren (AE)
- Erwan Salaün (AE)
ATL People

Graduate Students

- Su Won Bae
- Pierrick Burgain
- Yu-Heng Chang
- Bethany Davis
- Matt Elliot
- Maxime Gariel
- Brian Kim
- Sang-Hyun Kim
- Evan McClain
- Jon Petersen
- Vlad Popescu
- Isaac Robeson
- Gustav Söveling

- Adan Vela
- Jeb Watson
- Yan Shu
- Clayton Tino

Undergraduate Students

- Abigail Diocares
- Partick Eden
- Andrew Mahon
- Jong Wook Park
- Robert Schlein
- Lawrence Wong
ATL People

Graduate Alumni/ae

- Marcus Lowther (Metron)
- Gaurav Nagle (Sensis)
- Senay Solak (U Mass Amherst)
- Heinrich Souza (UK)

Undergraduate Alumni/ae

- Abhizna Butchibabu (MIT)
- Sathya Silva (NASA)
- Dilip Thekkoodan (NUS)
ATL Advisors

Cynthia Barnhart
- Associate Dean of Engineering
- MIT

Thierry Beauvais
- Technical Director
- Thales Air Systems Division

Carl Burleson
- Director Office of Environment and Energy
- FAA

Michael Clarke
- Director of Optimization Solutions
- Sabre Airline Solutions

Seymour Douglas
- Executive Director Analytics
- Cox Communications

Hugo Resende
- Senior Manager Marketing Strategy
  (formerly Chief Scientist)
- Embraer

Scott Simcox
- CEO
- ATAC Corporation

Barry Smith
- Executive Vice-President and Chief Scientist
- Sabre-Holdings (retired)

Neil Stronach
- Senior Vice-President System Operations
- Delta Air Lines

Karlin Toner
- Director
- Joint Planning and Development Office
ATL Research Projects - Current

Surface Operations (1)

- Collaborative Decision Making (CDM)
  - Sponsor:
    - Thales
  - Objective(s):
    - Analyze and develop models for airport surface operations
    - Identify opportunities for technology insertion
  - ATL Investigator(s):
    - Feron (PI), Clarke

- Surface Traffic Optimization in the Presence of Uncertainties
  - Sponsor:
    - NASA
  - Objective(s):
    - Characterize the constraints and uncertainties that affect surface traffic operations
    - Develop optimization strategies, architectures, and algorithms that are robust to uncertainties
    - Define a set of scenarios for the evaluation of the optimization algorithms and strategies
    - Conduct numerical experiments to quantify the performance of the algorithms and strategies
  - ATL Investigator(s):
    - Clarke (PI), Feron, Johnson, Li (Project Manager)
  - External Collaborator(s):
    - Balakrishnan (MIT); Rappaport (Sensis); Solak (U Mass Amherst)
Surface Operations (2)

- Modeling Environmental Factors in Surface Traffic Optimization (MEFISTO)
  - Sponsor:
    - NASA (subcontractor to Metron Aviation)
  - Objective(s):
    - Provide a unifying approach and supporting tools for making environmental constraints an integral part of the design of airport concepts
    - Extend real-time algorithms that enable interaction of planning algorithms concerned with different aspects of the surface-optimization problem (safety, efficiency, and environmental impacts)
    - Provide a deeper understanding of the benefits that could be achieved in emissions, noise, and fuel efficiency as NGATS enables increases in capacity (and likely traffic levels) via new technology and re-designed airportals
  - ATL Investigator(s):
    - Clarke (PI), Li (Project Manager)
  - External Collaborator(s):
    - Thompson (Metron); Sherry (George Mason)
Terminal Area Operations (1)

- Continuous Descent Arrival (CDA)
  - Sponsor:
    - FAA PARTNER
  - Objective(s):
    - Develop algorithms and tools for optimizing the vertical profile and spacing of RNAV/RNP arrivals
    - Conduct flight evaluation tests at airports (e.g. ATL)
    - Support implementation of permanent procedures (e.g. LAX)
  - ATL Investigator(s):
    - Clarke (PI), Brooks (Project Manager), Ren
  - External Collaborator(s)
    - Boyce (Delta)
    - Allerdice, Chambers, Purefoy, White, Zondervan (FAA)
Terminal Area Operations (2)

- Characterization of and Concepts for Metroplex Operations
  - Sponsor:
    - NASA
  - Objective(s):
    - Identify the dependencies and interactions between metroplex airports
    - Develop a classification scheme for metroplex dependencies
    - Determine the impact of NGATS concepts and capabilities on metroplex operations
    - Investigate new and innovative methods for increasing metroplex capacity
  - ATL Investigator(s):
    - Clarke (PI), Ren (Project Manager)
  - External Collaborator(s):
    - Crisp, den Braven, Gutterud (ATAC)
    - Cross, Lewis, Sliney, Thompson (Metron)
    - Saraf, Schleicher, Timar (Sensis)
En Route Operations (1)

NextGen En Route Traffic Optimization

- Sponsor:
  - FAA PARTNER

- Objective(s):
  - Develop algorithms and tools for determining the trajectory changes that minimize the fuel and emissions required to resolve conflicts while meeting required time of arrival constraints
  - Develop decision support tool based on algorithms and evaluate their performance through human-in-the-loop studies

- ATL Investigator(s):
  - Clarke (PI), Feigh (co-PI), Dutta (Project Manager), Feron, Johnson
  - Crisp (ATAC)
  - Altus (Jeppesen)
  - Thompson (Metron)
En Route Operations (2)

- **Objective Measures of Airspace Complexity to Support Airspace Management**
  - **Sponsor:**
    - FAA PARTNER
  - **Objective(s):**
    - Measures of airspace complexity suitable for real-time decision aiding and airspace planning
  - **ATL Investigator(s):**
    - Clarke (PI), Feron, Salaün (Project Manager)

- **Graceful Degradation of Advanced Air Traffic Control Systems**
  - **Sponsor:**
    - Thales
  - **Objective(s):**
    - Analyze and develop models for en route and terminal area operations during component failure
    - Identify opportunities for technology insertion
  - **ATL Investigator(s):**
    - Feron (PI), Clarke
En Route Operations (3)

- Influence of Degraded Environment on Airspace Safety (IDEAS)
  - Sponsor:
    - NASA Ames
  - Objective(s):
    - Evaluate the health and safety of current and projected National Airspace System traffic against environmental degradations
    - Develop an effective health monitoring system for the air transportation system that may be used in current and future concepts of operations
  - ATL Investigator(s):
    - Feron (PI), Clarke
  - External Collaborator(s):
    - Emilio Frazzoli (MIT)
Airline Schedule Planning

- Fractional Ownership Aircraft and Crew Scheduling
  - Sponsor:
    - CitationShares
  - Objective(s):
    - Develop algorithms and tools for the scheduling of aircraft and crew in a fractional ownership
  - ATL Investigator(s):
    - Johnson (PI), Ergun

- Robust Scheduling
  - Sponsor:
    - --
  - Objective(s):
    - Develop algorithms and tools for creating airline schedule that are robust to disruptions
  - ATL Investigator(s):
    - Clarke, Johnson
ATL Research Projects - Current (Cont’d)

Airline Schedule Planning (2)

- Optimal Airport Terminal Configuration and Gating
  - Sponsor:
    - --
  - Objective(s):
    - Develop algorithms and tools for determining optimal layout of airport concourses and aircraft gate assignments considering both passenger connection and security considerations
  - ATL Investigator(s):
    - Clarke, Johnson
Airline Operations and Recovery

- Integrated Recovery
  - Sponsor:
    - Sabre
  - Objective(s):
    - Develop optimization algorithms for integrated recovery (simultaneous recovery decision-making)
  - ATL Investigator(s):
    - Johnson (PI), Clarke