Multimodal Transportation Analysis in the NextGen Era: Challenges and Opportunities

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Aviation Challenges and Opportunities

NextGen

Policies and Investments

1. Intermodal Efficiency (LOS)

2. Airport/Airspace Capacity and Efficiency

3. Competing Modes

Aviation System Demand

Exogenous Effects (cost factors, Socioeconomics)
Multimodal modeling quantifies the utility of travel for various modes of transportation.
TSAM is an effort to understand multimodal intercity travel

- 9 million county pairs (3,076 × 3,076 counties)
- Automobile, commercial air, and air taxi travel
- Trips greater than 100 miles
- Business and non-business trips
- 5 household income groups
- 3 types of metropolitan statistical areas
- Four steps process: trip generation, trip distribution, mode choice, network assignment
- Standalone software: GIS framework and MATLAB computation
Multimodal Modeling Framework

- Trip Generation
- Trip Distribution
- Mode Choice
  - Road Network Assignment
    - Highway Traffic Assignment (FAF/TransCAD)
      - Vehicle Miles Traveled (VMT) and Link Speed
        - Emissions and Fuel Consumption (Mobile 6)
        - Highway Travel Fatalities
        - Delays, Road Congestion Levels
          - Updated Travel Time And Cost
  - Commercial Airline Network Assignment
    - Commercial Airline Flight Frequencies
  - Air Taxi Network Assignment
    - Air Taxi Flight Frequencies
  - Rail Network Assignment
    - Rail Frequencies
      - Delays, Station Congestion Levels
  - Airspace Simulations (ACES, RAMS)

Legend:
- Four Step Model
- External Process
- Output
- Future Work

Future Feedback Loop

Equilibrium? No

Yes - End
Old Benchmarks for Multimodal Validation

• ATS 1995 is the only survey that provides a nationwide standard of mode choice behavior for intercity travel
Trip Rate Changes with Time

People were more mobile in 2001 (and perhaps today) than 13 and 30 years ago

Source of data: Bureau of Transportation Statistics
Analysis by Virginia Tech Air Transportation Lab (Henderson and Trani, 2006)
Network assignment loads the commercial airline and air taxi demand onto the network.
The Freight Analysis Framework (FAF) is adapted for automobile intercity traffic assignment in TSAM.
Commercial airline network and schedule (supply) need to evolve based on future commercial airline demand.

Evolution of the airline fleet

Policies

NextGen

Evolution of airline / airport network

Year = 2008

Year = 2025
Modeling the NextGen System

• NextGen - Next Generation Air Transportation Systems
• Nextgen is associated with technical changes to the system allowing faster transit time at airports (i.e., faster screening and services)
• NextGen provides added airport/airspace capacity (values still debatable)
• Initial goal of NextGen was to reduce travel time by 30% for passenger in the year 2025 (very ambitious goal)
• This implies large reductions in transit time at airports (the speed of subsonic aircraft is not expected to change drastically in the next 20 years)
NextGen Modeling Assumptions (year 2025)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Airport Processing + Slack Time (hrs)</th>
<th>Airline Scheduled Time and Fares</th>
<th>Airport egress time (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline Scenario</strong></td>
<td>1.8 (Large hub)</td>
<td>1X AFF = 1 ($2000)</td>
<td>0.75 Large hub</td>
</tr>
<tr>
<td></td>
<td>1.5 (Medium hub)</td>
<td></td>
<td>0.75 Medium hub</td>
</tr>
<tr>
<td></td>
<td>1.0 (Small Hub)</td>
<td></td>
<td>0.50 Small/Non hub</td>
</tr>
<tr>
<td><strong>NextGen 1</strong></td>
<td>0.9 (Large hub)</td>
<td>1.0 X ($2000) AFF = 1.0</td>
<td>0.50 Large hub</td>
</tr>
<tr>
<td>Reduction in gate-to-gate time</td>
<td>0.8 (Medium hub)</td>
<td></td>
<td>0.50 Medium hub</td>
</tr>
<tr>
<td>reduction goal</td>
<td>0.5 (Small/Non-hub)</td>
<td></td>
<td>0.30 Small/Non hub</td>
</tr>
<tr>
<td><strong>NextGen 2</strong></td>
<td>0.9 (Large hub)</td>
<td>0.95 X ($2000) AFF = 1.0</td>
<td>0.50 Large hub</td>
</tr>
<tr>
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</table>

- Reducing intermodal processing times at the airport along with a 5% reduction in scheduled airline time increases passenger enplanements by 15%
- Most flights added fall into the 150 to 700 statute miles distance range
- Average overall flight distance reduced approximately 62 miles with NextGen 2
Assumption for NextGen

- Assume (for a moment) that added demand loads in the system produce similar average delay per flight of the baseline scenario.
NextGen 2 Airport Demand Map
Auto Trips Produced (NextGen 2)
With NextGen 2 in place, scheduled airline demand could increase by 15% (NextGen Scenario 2025)

Change in Commercial Air Demand (Annual Person Trips)

- Substantial Gains with NextGen
- Moderate Gains with NextGen
- Small Gains with NextGen

One-Way Route Distance (sm)
NextGen 2 could induce another 130 million enplanements in 2025

- **NextGen 2**
  - Average auto distance = 251 miles
  - Average commercial air distance = 1,065 miles

- **NextGen 1**

- **Baseline**
  - Average auto distance = 263 miles
  - Average commercial air distance = 1,127 miles
Spatial Distribution of Travel Time Savings under NetxGen (2025)

35 Billion Saved per Year (Travel time savings)

325 million hours saved by business travelers
713 million hours saved by personal travelers
Multimodal Possibilities

- On-demand air taxi
- Limits of growth reached at some airports
- Shift to secondary airports
- Competing modes are developed and take some of the demand load
- Some corridors can be serviced by high-speed rail
Comparative Travel Times for Different Rail Technologies in the Northeast Corridor

![Bar chart comparing travel times for different rail technologies between New York and Washington, Boston and Washington, and New York and Boston. The technologies include Accelerail-90, Accelerail-110, Accelerail-125, Accelerail-150, hsr, Maglev, and Amtrak. The travel times are measured in hours.]
Rail Trips Produced in 2025
Can Rail Complement Commercial Air Transportation?

• Likely but limited to congested corridors (if the price is right)
  – Northeast corridor (Boston-Washington)
  – California (San Francisco-San Diego)
  – Northwest corridor (Seattle-Eugene)
  – Florida (Miami-Jacksonville)
  – Minneapolis-Chicago corridor

• Requires extensive work on track improvements and signal control infrastructure
Study Findings

• Multi-modal transportation choice models are “modestly” capable of predicting air transportation demand changes due to NextGen investments and improvements
• NextGen is a multi-modal solution (access/egress times and processing times cannot be ignored)
• With improvements, other modes of transportation can play a role to complement aviation demand
• The optimistic assumptions made for gate-to-gate travel time in NextGen 2 could have a substantial effect in the demand for air transportation (15% increase in 2025 compared to the do-nothing alternative – baseline scenario)
Challenge for NextGen

• The delay function under NextGen needs to be derived realistically to quantify door-to-door travel times
Challenges (cont.)

• Travel survey data is old and incomplete
  – Mode choice calibration of TSAM would be greatly improved if zip code/county and airport/station information from the American Travel Survey (1995) data were publicly available
  – Future transportation surveys should collect and distribute zip code/county and airport/station information

• Some help is on the way (maybe)
  – NHTS 2008
  – ACRP survey guidebook
Final Words (More Challenges)

• People behavior is difficult to predict with mathematical models using 2-6 variables

• Los Alamos Lab anecdote on TRANSIMS
  – “Easier to predict the behavior of atomic and sub-atomic particles than a person’s daily commute from A-B-C”

• Airline behaviors (price and network evolution) are sometimes driven hard to predict

• We to keep trying to understand the complex dynamics of multimodal modeling