Briefing at University of Cincinnati

Air Traffic Management Research at NASA

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Outline

• Need to modernize the air traffic system
• Informal history of air traffic modernization
• Air traffic control operations
• Technical challenges
• Concluding remarks
NASA
Demand for air travel continues to grow

North American air transportation system is the most productive in the world.
Substantial increase in traffic expected over next 20 years.
Demand for air travel continues to grow

...but the system is becoming saturated
Delays are a symptom of saturation

Annual Air Traffic Delay

September 20, 2012
Outline

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1929
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1932

1935
Briefing at University of Cincinnati
Briefing at University of Cincinnati

1960

1964
1981

Advanced Automation System

- Big Bang approach underestimated complexity
- Excessive faith in new technologies
- Customizable interfaces led to state explosion for V&V
- Politics
Briefing at University of Cincinnati
Outline

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Air Traffic Control Objectives

- Keep aircraft safely separated
- Minimize delay
Outline

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Air Traffic Management Research

- What’s so hard about it?
  - Rampant uncertainty
  - Safety-critical, real-time, human-centered
  - How to test and transition to new technology?

A success story: TMA
Traffic Management Advisor

- Expected diners if we do nothing
- Scheduled diners given wait time

Restaurant capacity
A success story: TMA
Traffic Management Advisor

- Expected arrivals if we do nothing
- Scheduled arrivals using TMA

No. of arrivals

Airport capacity

A success story: TMA
Traffic Management Advisor

Scheduled arrivals to LAX

Typical capacity: 4-5 arr per 5 mins (14 per hour)
A success story: TMA

- Noon rush at LAX using miles-in-trail spacing
  - Airborne holding
  - Difficult merge situations

- Noon rush at LAX using TMA metering
  - No airborne holding
  - Smooth merges
  - Even workload distribution

Images courtesy of FAA ADZ.

Trajectory Modeling
Dynamic Routes

Current active flight plan route
Concluding Remarks

- Urgent need to modernize
  - Today's system routinely operates at its limit
  - Impinging on US economic growth

- Extraordinarily complex problem space
  - Rampant uncertainty
  - Human-centered
  - Don’t mess up!

- Make a difference
Air Traffic Management Research at NASA

www.aviationsystemsdivision.nasa.gov
intern.nasa.gov
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usajobs.gov

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Simulation Results

Today’s Traffic - Actual Operations

Automation Detects, Human Resolves

One controller doing work of 5 to 10 people. No loss of separation.

Auto Resolution Results Summary

<table>
<thead>
<tr>
<th>Traffic level, Cleveland Center</th>
<th>1X</th>
<th>~2X</th>
<th>~3X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic count (24 hours)</td>
<td>7000</td>
<td>17800</td>
<td>26000</td>
</tr>
<tr>
<td>Conflicts detected and resolved</td>
<td>532</td>
<td>1572</td>
<td>3099</td>
</tr>
<tr>
<td>% flights in conflict</td>
<td>12</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>Mean delay (sec)</td>
<td>21</td>
<td>22</td>
<td>25</td>
</tr>
</tbody>
</table>

100% of en-route conflicts resolved.

Cost of resolution rises acceptably with traffic level.
Tactical safety assurance vs. Today’s conflict alerting

- 69 Operational Errors
  - Tactical safety assurance
  - Today’s conflict alerting

Percent of conflicts detected

Alert lead time, sec

- > 30
- > 60
- > 90

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