Integrating best-equipped best-served principles in ground delay programs

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Introduction

• BEBS is an important policy tool under NextGen
  – Represents a new system for flight prioritization
  – Should help to incentivize aircraft operators to equip with appropriate technologies

• TFM represents an important avenue for exploring BEBS implementation
  – GDP is most mature TMI, so it provides the most natural avenue for exploration
Research outline

• Objectives:
  – What are some methods for integrating BEBS principles in GDP?
  – What are the efficiency/equity implications of integrating BEBS principles in GDP?

• Approach
  – Develop rule-based allocation methods for GDP planning considering schedule, flight equipage, and other characteristics
  – Examine realistic case study to assess performance
Assumptions

- Two classes of aircraft:
  - Unequipped
  - Equipped
- Equipped flights “create” new capacity during GDP → two classes of slots:
  - Base: available to all flights
  - Enhanced: available only to equipped flights
- Example application: GBAS/RNP at EWR to access Rwy 11/29 during IFR
Overview of proposed methods

• Three allocation methods developed
  – Try to build on established TFM allocation principles
  – Address equipage characteristics in different ways

1) Perform RBS on base and enhanced slot set
2) Exempt equipped flights from GDP
3) Use baseline RBS allocation with iterative compression

• Example:

  • All flights scheduled earlier than earliest slot
Full slot set RBS method (1)

• Perform RBS simultaneously considering both base and enhanced slot sets
  – For each slot, choose earliest properly equipped flight
• Similar to current RBS, but with added condition
Exemption allocation method (2)

• Extend class of exempted flights to include those properly equipped
  – Implement by assigning equipped flights to earliest slot of either type

• Should grant greatest advantage to equipped flights, but may be inefficient
RBS with compression method (3)

- Perform RBS for all flights using base slot set
- Add each enhanced slot, beginning with the earliest
  - Compression after moving equipped flight to enhanced slot
- Should direct benefits to airlines that choose to equip some portion of fleet
Relevant policy questions

- *Distribution of indirect benefits*

- Distribute to other equipped aircraft/operators, or within same airline?
  - RBS baseline with compression is most explicit about this

- Measured relative to delays under base RBS delay
Relevant policy questions

- *Disadvantaging unequipped flights*

- Some unequipped flights may be assigned later than RBS time to accommodate equipped flights
  - Only exemption method susceptible

![Diagram showing flight slots and penalties](image)
Relevant policy questions

• **Throughput maximization**

• A trade may exist between maximizing throughput and prioritizing equipped flights

**Exemption**

- Slots for equipped flights: 1, 2
- Slot for last flight: 7

**RBS/Compression**

- Slots for equipped flights: 2, 6
- Slot for last flight: 6
Case study setup

• Examine efficacy of each method at EWR
• Long N-S runways typically used for most ops
  – Under VFR conditions, 11 or 29 may be used for overflow ops → AAR of 42-48
  – Under (Low) IFR conditions, typical AAR is 28-38
• For case study, assume that either GLS (Rwy 11) or Low RNP (Rwy 29) can enable use during IFR conditions
  – Assume base AAR of 34
  – Assume that use of 11/29 adds 8 flights/hour
Case study data

- Schedule data from June 8, 2007
  - GDP imposed from 16:30-03:00 UTC
- Fleet: 413 flights (primarily RJ & narrowbody)
- Scenario rates: Base 34, Enhanced +8
Equipage scenarios

A. All COA RJ aircraft
   – Dominant hub carrier, strong influence on traffic

B. All COA, AAL, DAL RJ aircraft
   – Include next two largest operators in case study

C. All AAL, DAL RJ aircraft
   – Only two smaller carriers, benefits should be less

A. Variable fraction of all RJ aircraft
   – Examine evolution of delays with increasing equipage levels
Analysis of results

- Comparison of aggregate mean delays across methods and equipage scenarios
Analysis of results

- Comparison of aggregate mean delays across methods and equipage scenarios for equipped and unequipped flights.
Analysis of results

• Comparison of aggregate mean delays across methods and equipage scenarios for equipped and unequipped airlines
Analysis of results

- Comparison of aggregate mean delays for increasing equipage levels for equipped and unequipped flights

No particular carrier assumed to have equipped

![Graph showing average delay (minutes) vs. RJ equipage fraction for different methods.](image-url)

• Comparison of aggregate mean delays for increasing equipage levels for equipped and unequipped flights
Conclusions

• Examined three methods to incentivize equipage using BEBS principles in a GDP
  – Each addresses policy questions in a different manner

• Looking to expand analysis to other airports or equipage scenarios where best-performing aircraft induce performance gains