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

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TFM & BEBS background

- Best-equipped best-served is an important policy tool under NextGen
  - Represents a new system for flight prioritization to supplement schedule order

- Traffic flow management is the family of procedures for strategic control of airport and airspace congestion
  - Represents an important avenue for exploring BEBS implementation

- Ground delay programs used to limit arrival flows into airports by assigning delays to flights before departure
  - Most widely used and best developed TFM procedure
  - Thus provides a natural avenue for exploration of BEBS

- Study more accurately reflects “best-performing best-served”
Research approach

• Examine fairness and performance enhancements must for different allocation methods and equipage scenarios

• Develop rule-based allocation methods for GDP planning considering schedule, flight equipage, and other characteristics

• Examine case study to assess performance
  – EWR Rwy 11/29 use during GDP

• Assumptions:
  – Two classes of aircraft – unequipped and equipped
  – Equipped flights “create” new capacity during GDP – base (available to all) and enhanced (for equipped only) slots
Overview of proposed methods

• Three allocation methods proposed
  – Build on established TFM allocation principles (e.g., ration by schedule, compression)
  – Address equipage characteristics in different ways

• Allocation methods:
  1. Exempt equipped flights from GDP
  2. Two stage with airline specific compression
  3. Single pass RBS
Procedural notation

• Extensive use of graphical examples to demonstrate procedures

• Assumptions:
  – Two airlines:
  – Slot set
  – Hashed flights/slots indicate equipage
  – All flights scheduled earlier than earliest slot
Exemption method

• 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
**Compression** method

- Perform RBS for all flights using base slot set
- Add each enhanced slot, beginning with the earliest
  - Compression after moving first equipped flight to enhanced slot
- Should direct benefits to airlines that choose to equip any portion of fleet
**Single pass method**

- Perform RBS simultaneously considering both base and enhanced slot sets
  - Loop through combined slot set one time
  - For each slot, choose earliest properly equipped flight
- Similar to current RBS, but with added condition
Relevant policy questions

1. How should *indirect benefits* resulting from increased capacity be distributed?

2. To what degree should *unequipped flights be penalized* to prioritize equipped flights?

3. If necessary, how should *tradeoffs between capacity and throughput* be addressed?
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 basic RBS allocation
Disadvantaging unequipped flights

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

**Compression**

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

• EWR frequently impacted by GDP
• Long N-S runways typically used for most ops
  – Under VFR conditions, 11/29 may be used for overflow ops, typical AAR is 42-48
  – Under (Low) IFR conditions, typical AAR is 28-38
Case study fleet data

- Schedule data from June 8, 2007
  - GDP imposed from 16:30-03:00 UTC
- Fleet: 413 flights, primarily Continental

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<tr>
<th>Class</th>
<th>Example types</th>
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<td>Other</td>
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Case study assumptions

- Either GLS (Rwy 11) or Low RNP (Rwy 29) can enable use during IFR conditions
  - All necessary policy/procedural changes are in place
- Because Rwy 11/29 is fairly short, only small aircraft may use it

- Base arrival rate (AAR) = 34 flights/hour
- Marginal AAR from Rwy 11/29 = 8 flights/hour
Equipage scenarios

1. All COA RJ aircraft
   - Dominant hub carrier, strong influence on traffic

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

3. All AAL, DAL RJ aircraft
   - Only two smaller carriers, benefits should be less

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
Conclusions

- Reasonable that BEBS may be used to introduce and distribute benefits of Next Gen
- Important to consider policy implications of method used for flight prioritization
  - Carefully directed benefits may help to incentivize equipage
- Additional work to examine stability of results suggests little dependency on particular case study
Other material
Comparison of delays

Average delay (minutes)

- Exemption
- Compression
- Single pass

Base delay, AAR=34
Base delay, AAR=42

Comparison of delays by equipage

Base delay, AAR=34

Base delay, AAR=42

Unequipped flights

Equipped flights

Allocation method

Exemption

Compression

Single pass
Comparison of delays by carrier

Average delay (minutes)

- Base delay, AAR=34
- Base delay, AAR=42

Allocation method

- Exemption
- Compression
- Single pass

Other airlines
COA
Alternate equipage scenarios

• Because COA is dominant carrier, has greatest potential to benefit

• Case 2: all COA, AAL, DAL RJ/turboprop aircraft
  – Overall benefits similar
  – Benefits spread more broadly over equipped carriers

• Case 3: only AAL, DAL RJ/turboprop aircraft
  – Overall benefits much smaller
Variable equipage fraction

No particular carrier assumed to have equipped