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

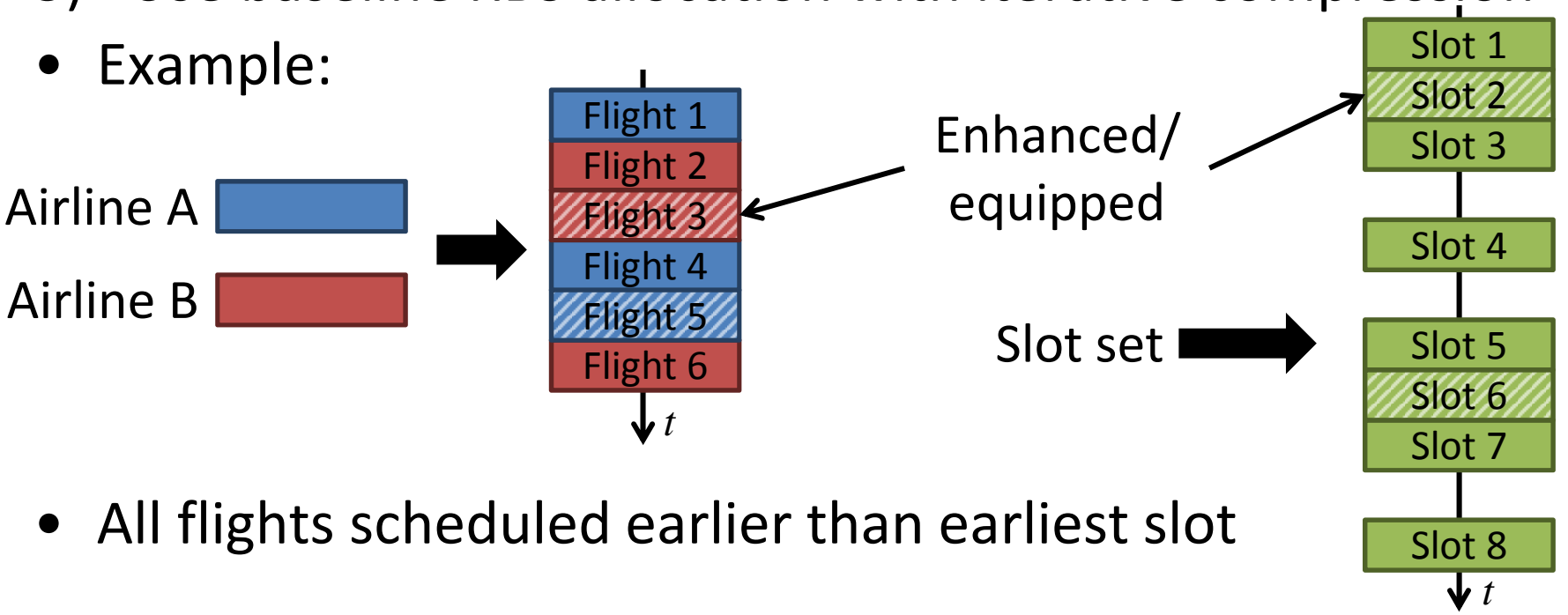
- Two classes of aircraft:
  - Unequipped
  - Equipped
- Equipped flights “create” new capacity during GDP→ two classes of slots:
  - Base: available to all flights
  - Enhanced: available only to equipped flights
- Example application: GBAS/RNP at EWR to access Rwy 11/29 during IFR

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

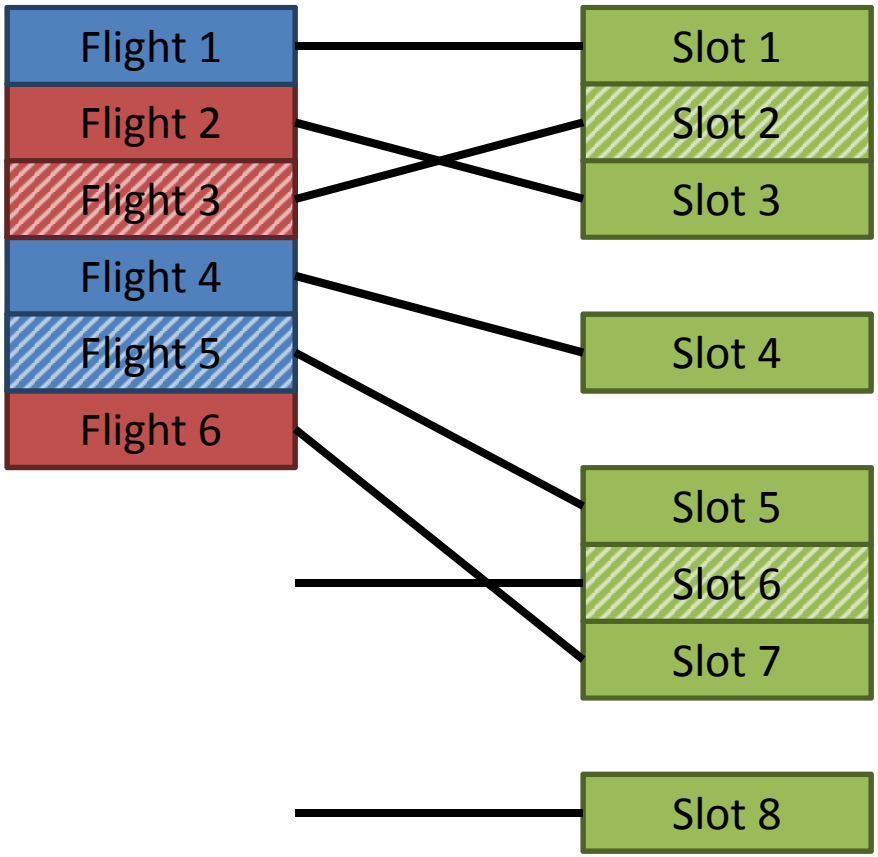
- Example:



- All flights scheduled earlier than earliest slot

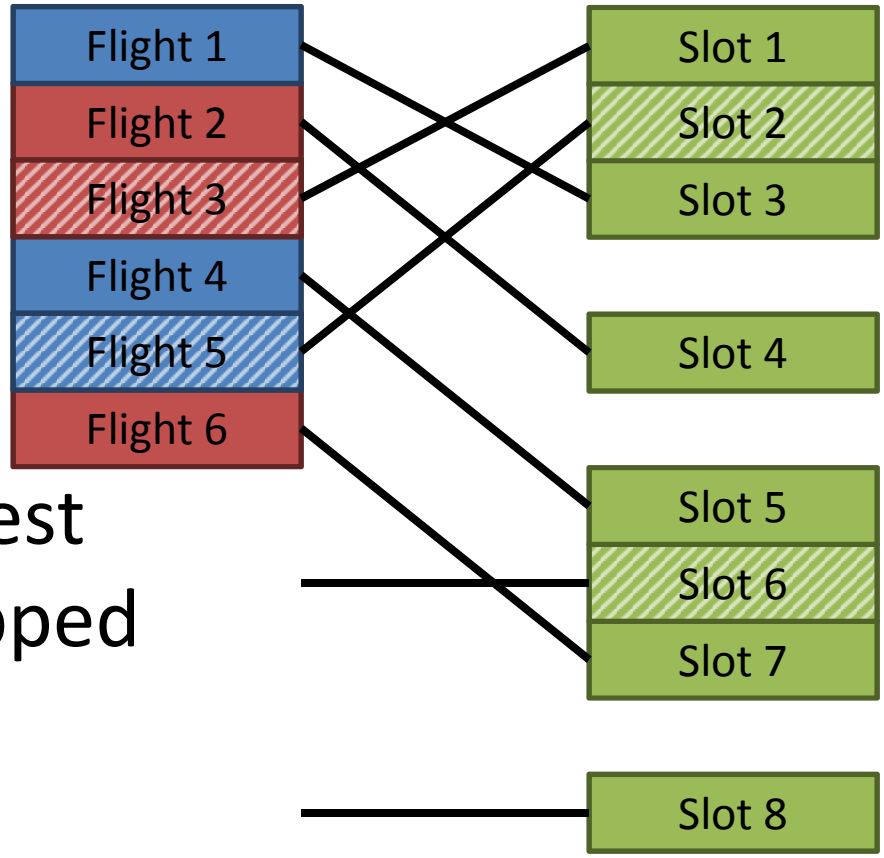
Full slot set RBS method (1)

- 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



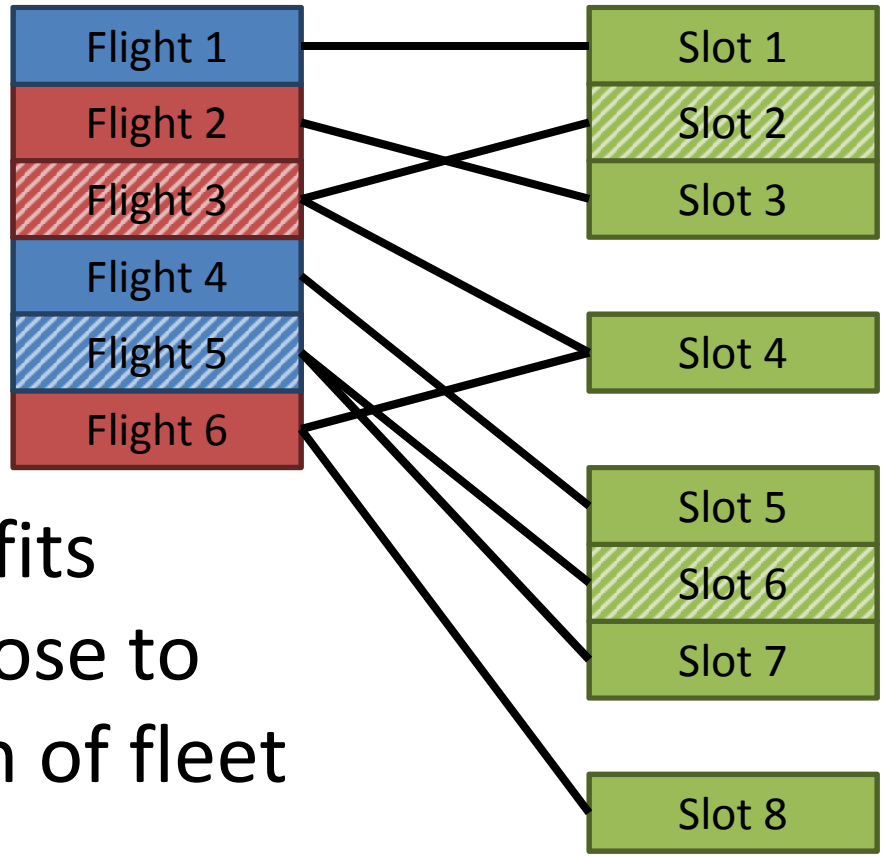
Exemption allocation method (2)

- 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



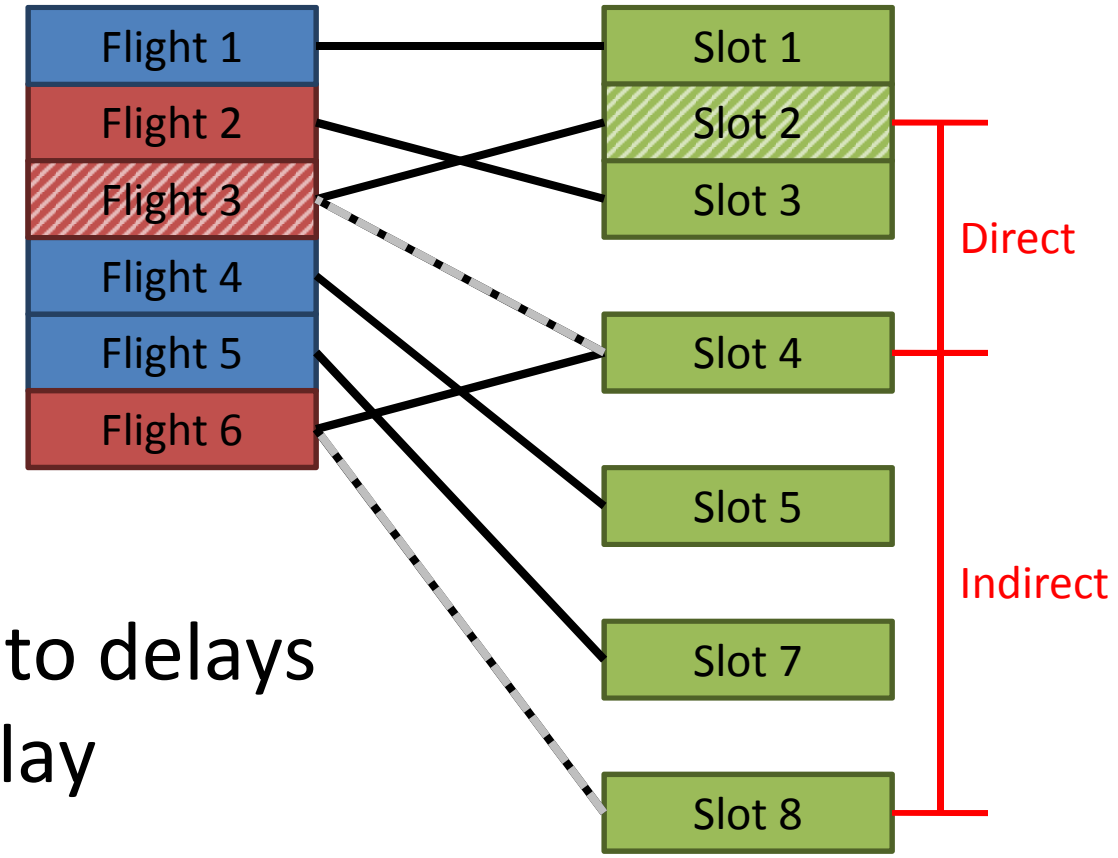
RBS with compression method (3)

- 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



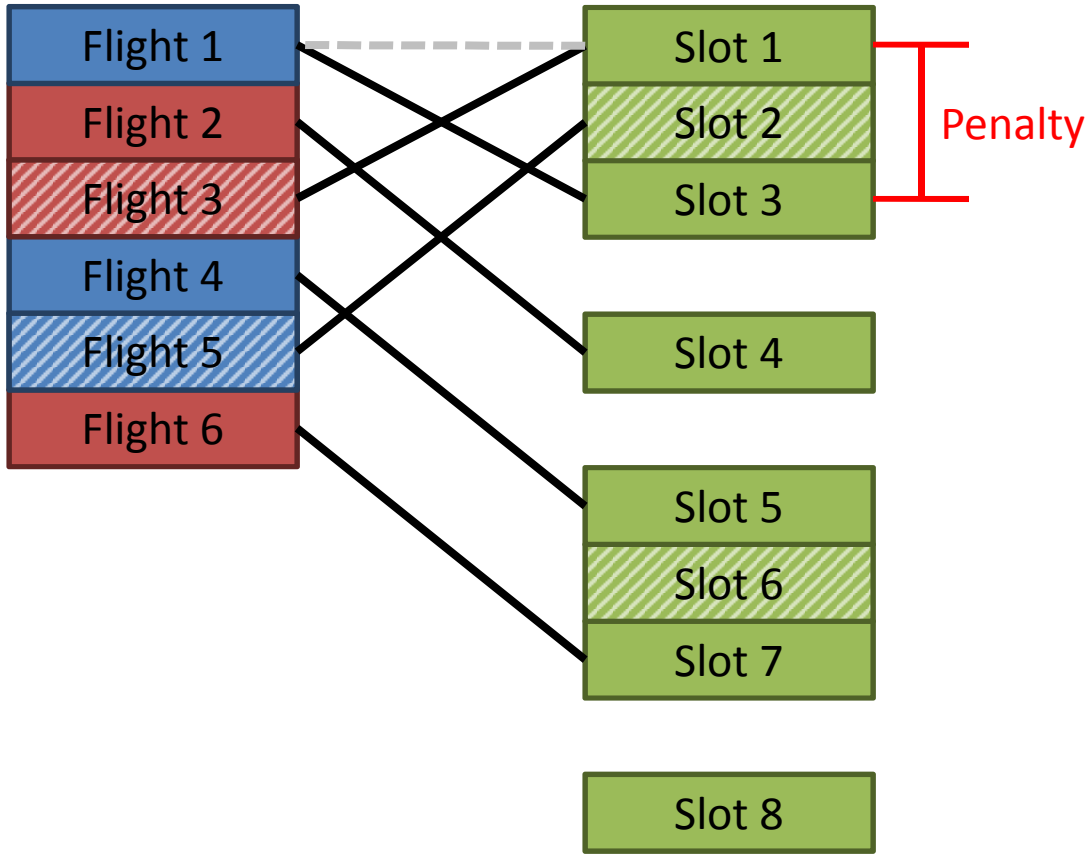
Relevant policy questions

- *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

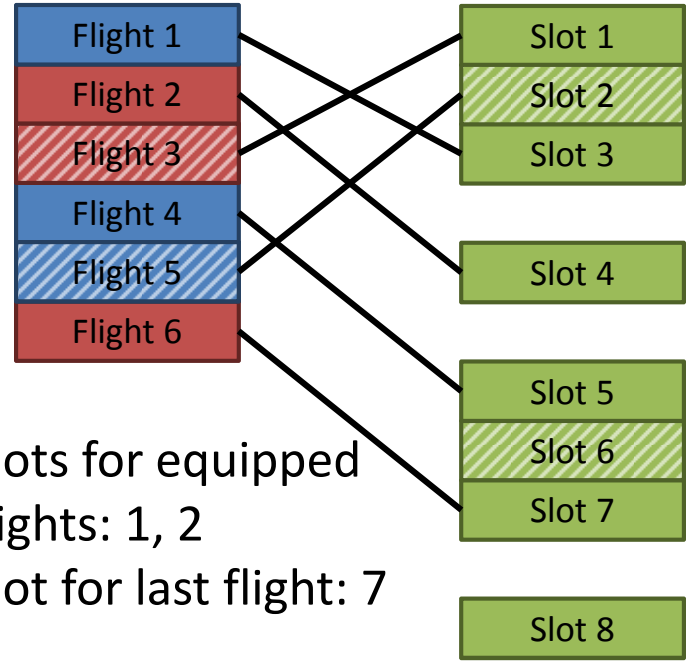
- *Disadvantaging unequipped flights*
- Some unequipped flights may be assigned later than RBS time to accommodate equipped flights
  - Only exemption method susceptible



Relevant policy questions

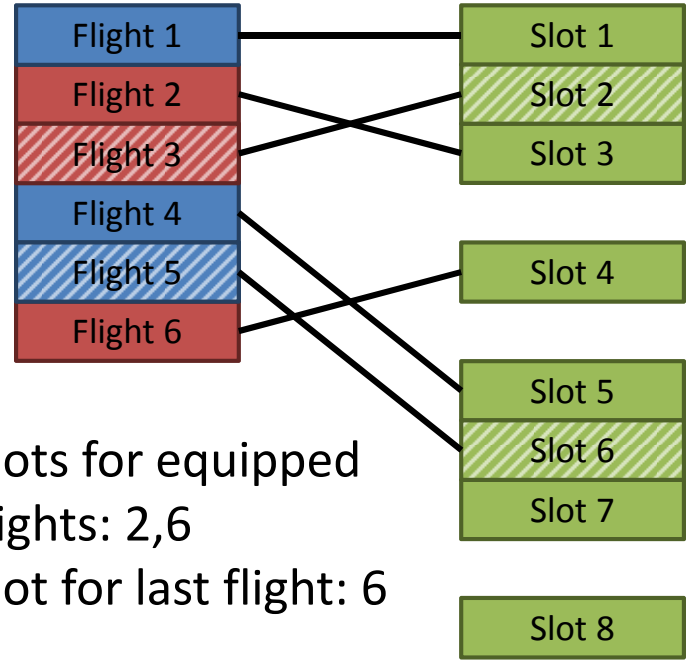
- *Throughput maximization*
- A trade may exist between maximizing throughput and prioritizing equipped flights

Exemption



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

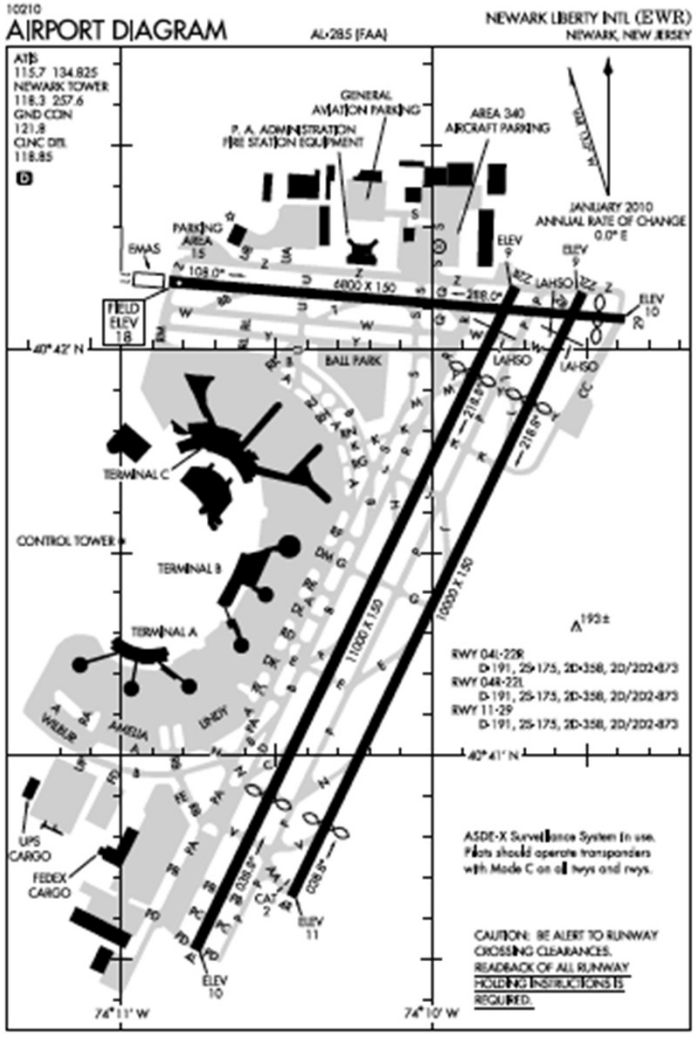
RBS/Compression



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

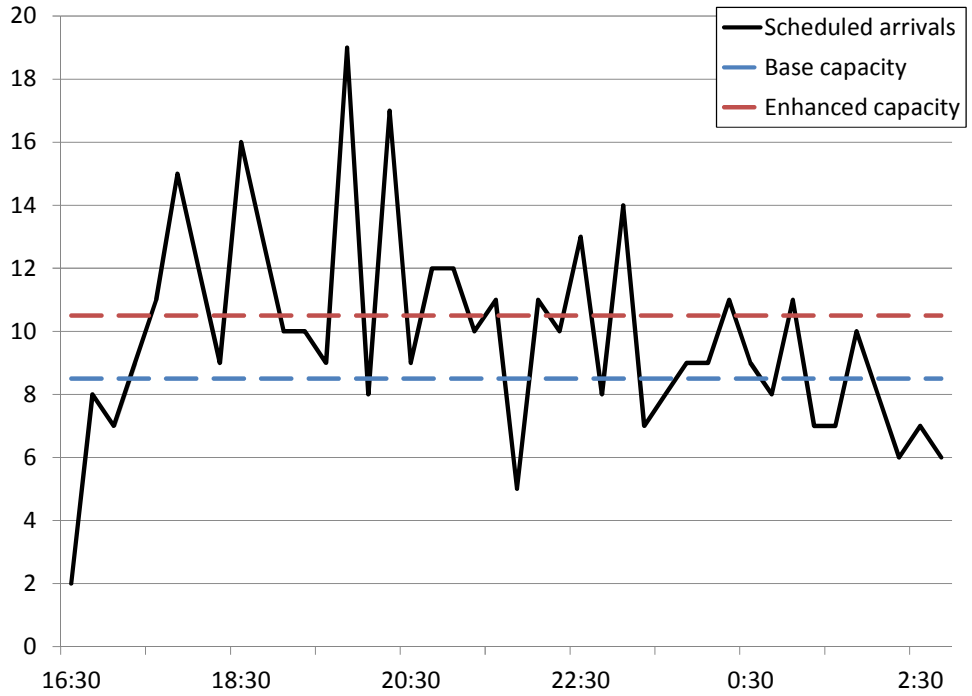
Case study setup

- 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



Class	Example types	Count
Heavy	A330, A340, B767, B777	40
Medium	A320, B737, MD80, DC9	219
Regional	E145, CRJ2, CRJ7	141
Other	LJ45, C550	13

Equipage scenarios

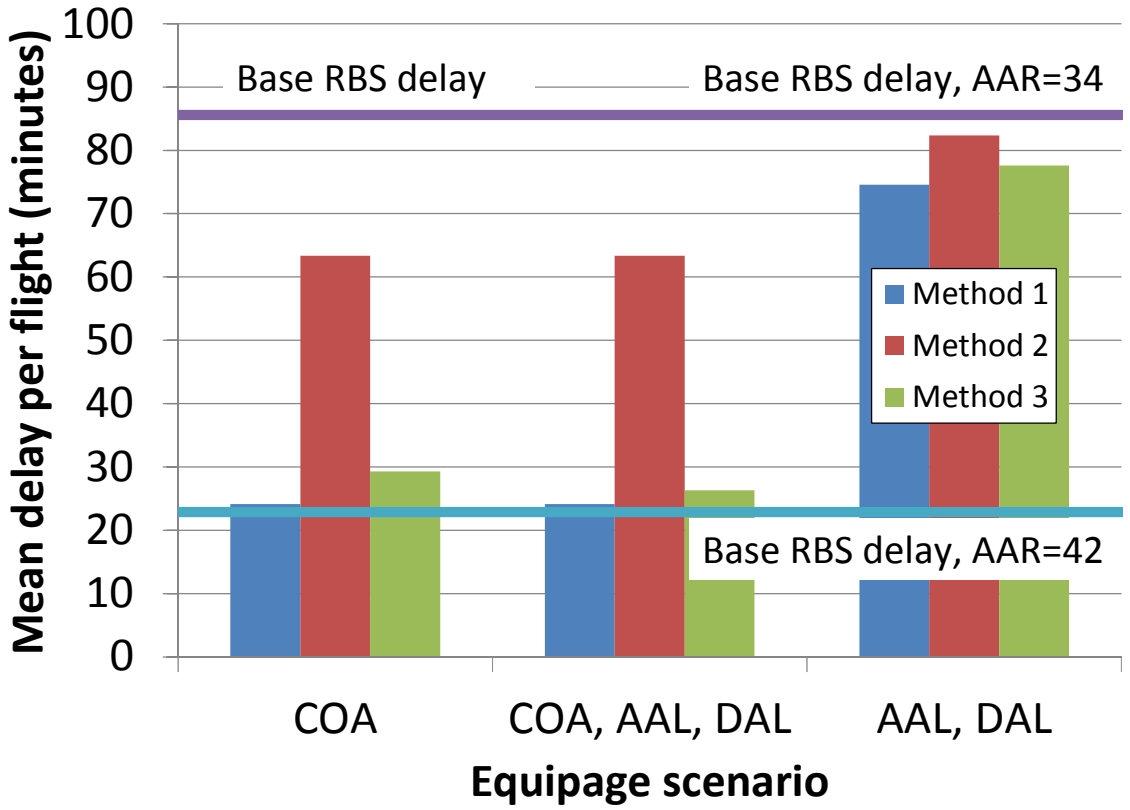
A. All COA RJ aircraft
   - Dominant hub carrier, strong influence on traffic

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

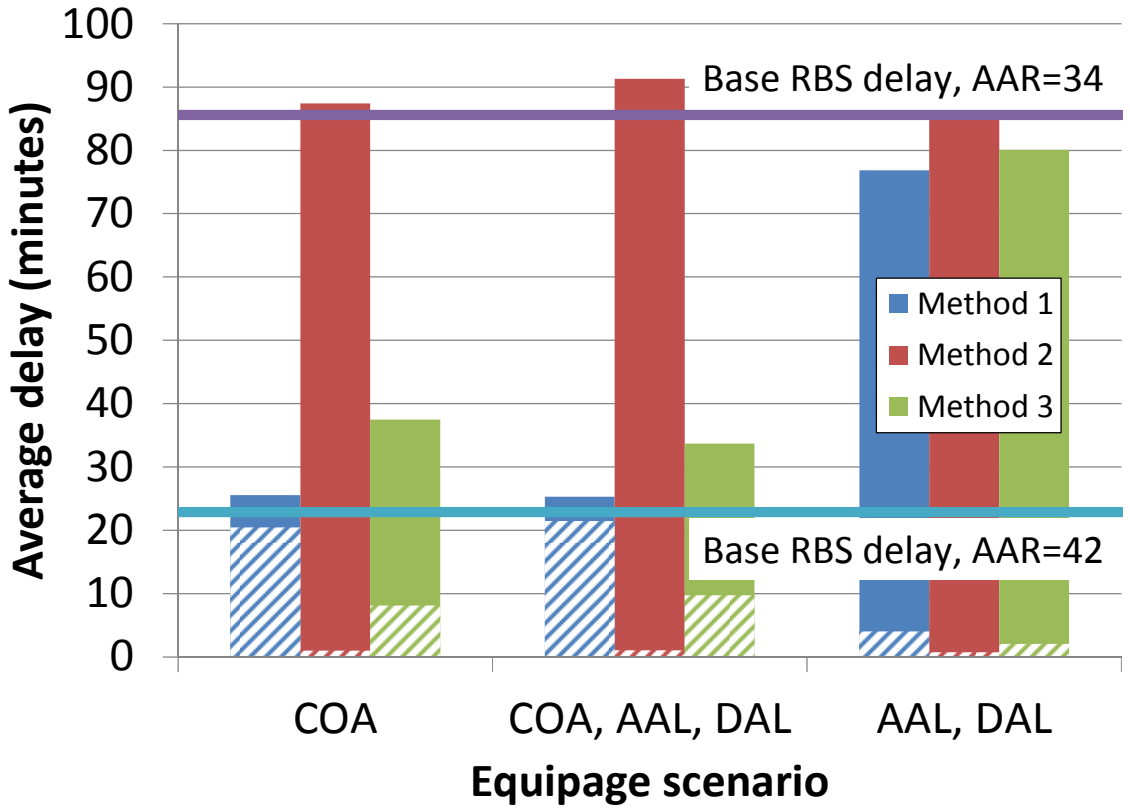
A. Variable fraction of all RJ aircraft
   - Examine evolution of delays with increasing equipage levels

Analysis of results



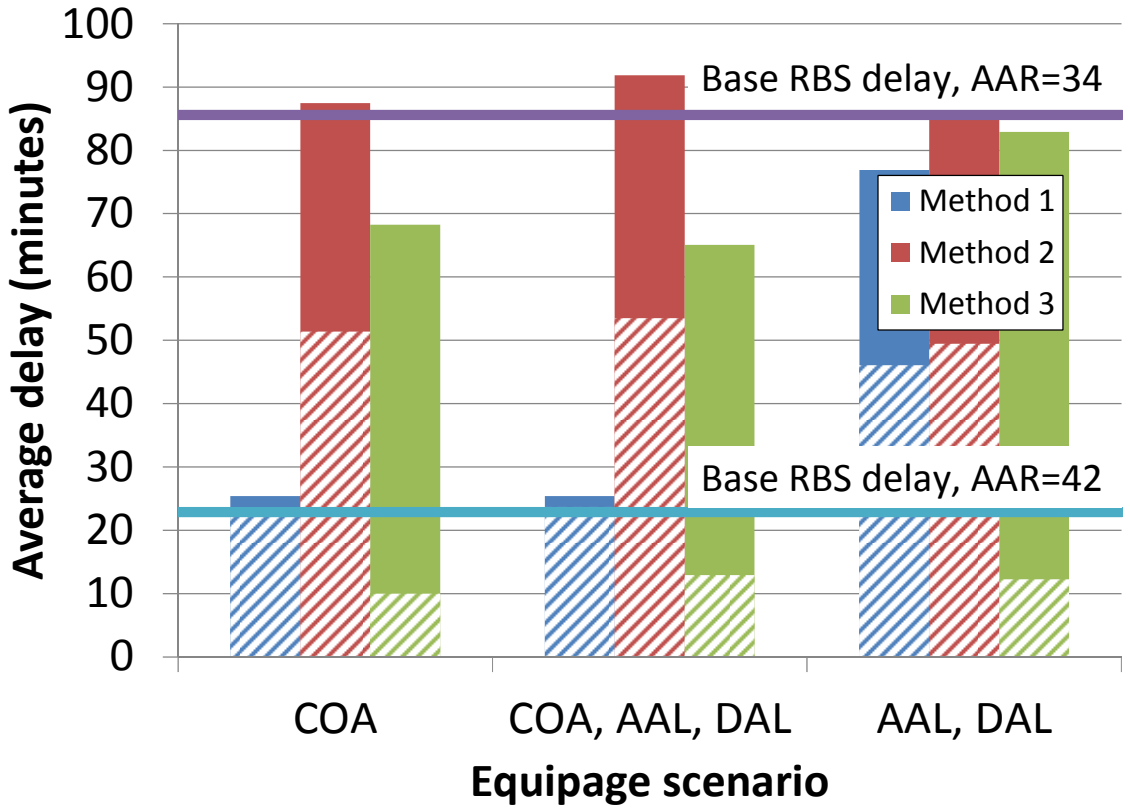
- Comparison of aggregate mean delays across methods and equipage scenarios

Analysis of results



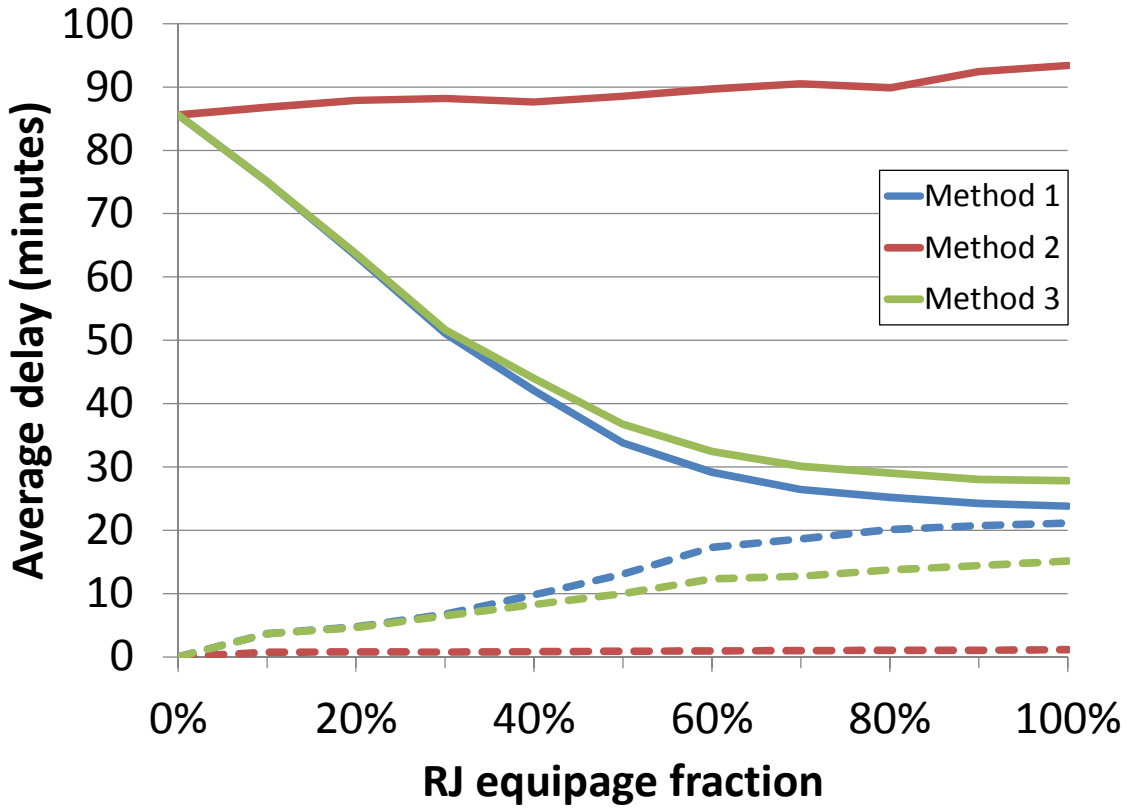
- Comparison of aggregate mean delays across methods and equipage scenarios for equipped and unequipped ***flights***

Analysis of results



- Comparison of aggregate mean delays across methods and equipage scenarios for equipped and unequipped ***airlines***

Analysis of results



No particular carrier assumed to have equipped

- 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