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

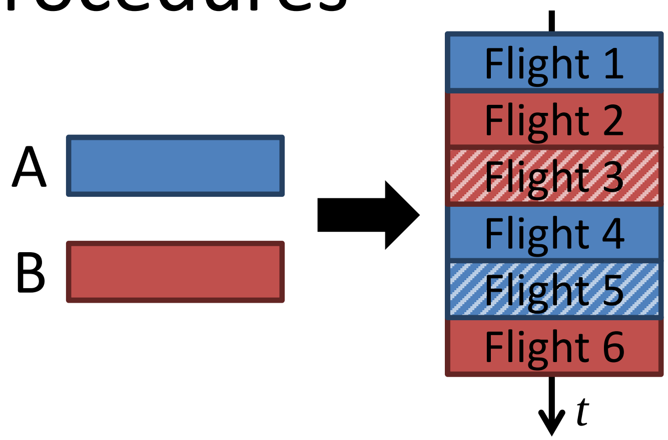
- Examine fairness and performance enhancements must for different allocation methods and equipage scenarios
- Develop rule-based allocation methods for GDP planning considering schedule, flight equipage, and other characteristics
- Examine case study to assess performance
  - EWR Rwy 11/29 use during 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

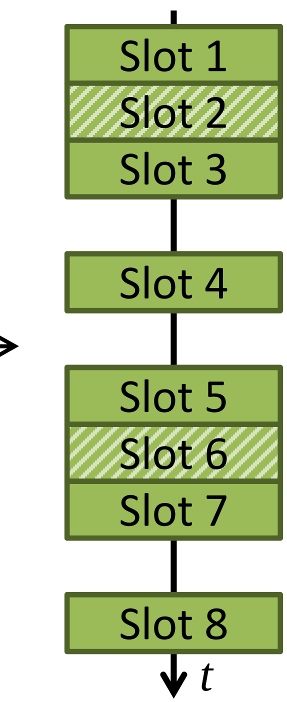
- Three allocation methods proposed
  - Build on established TFM allocation principles (e.g., ration by schedule, compression)
  - Address equipage characteristics in different ways
- Allocation methods:
  1. Exempt equipped flights from GDP
  2. Two stage with airline specific compression
  3. Single pass RBS

Procedural notation

- Extensive use of graphical examples to demonstrate procedures
- Assumptions:
  – Two airlines:



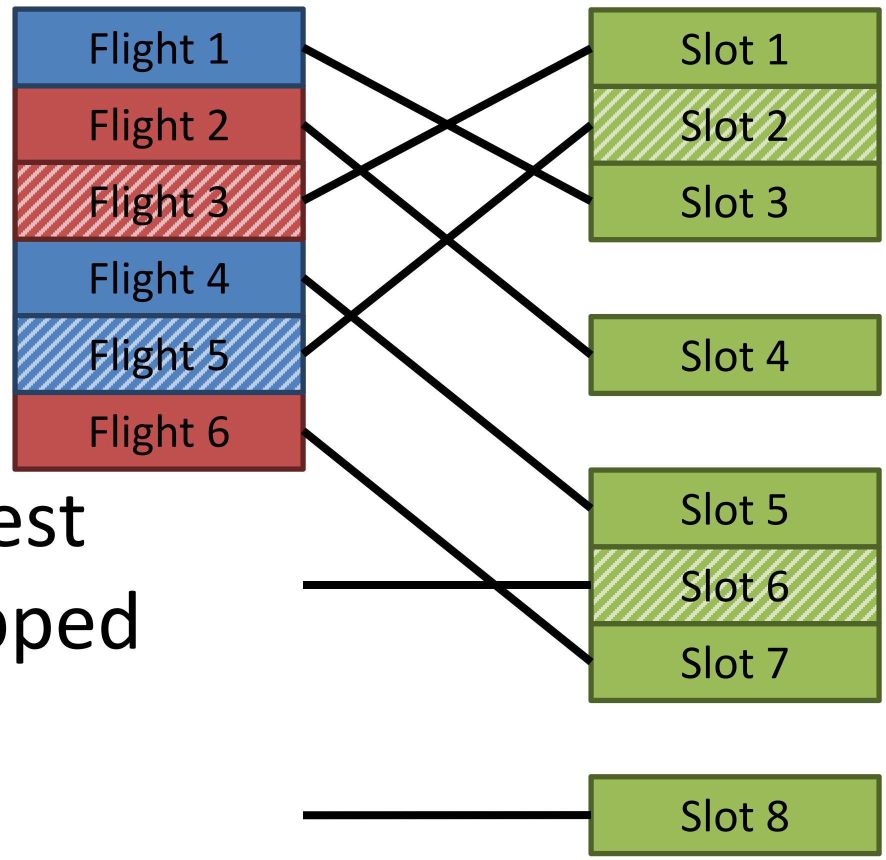
  – Slot set



  – Hashed flights/slots indicate equipage
  – All flights scheduled earlier than earliest slot

Exemption method

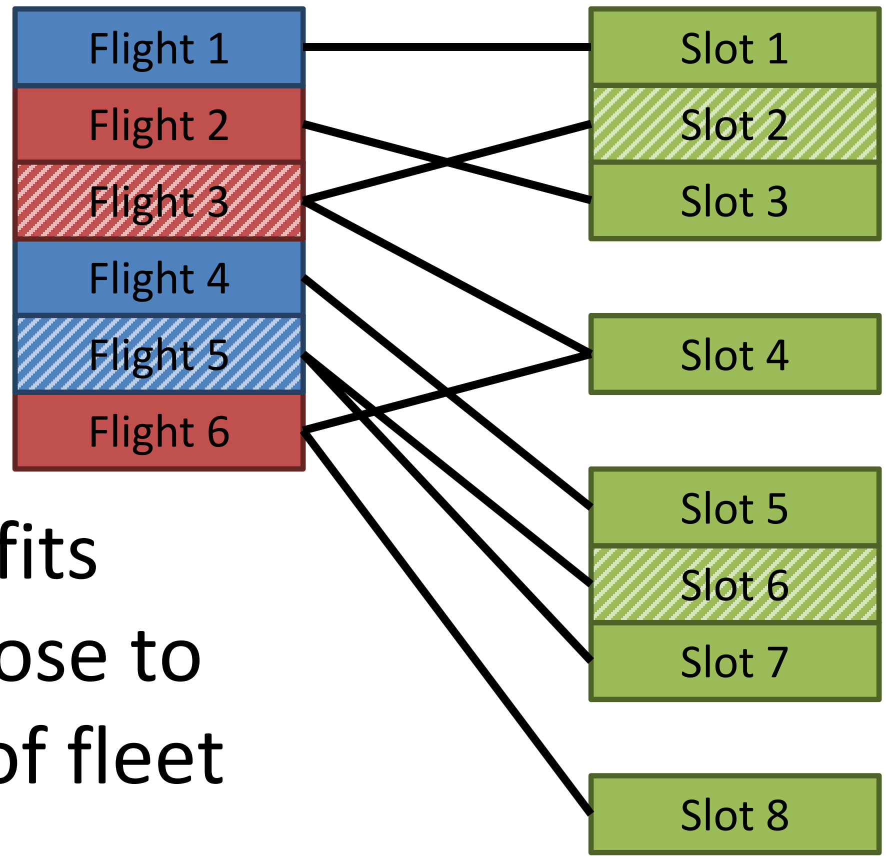
- Extend class of exempted flights to include those properly equipped
  - Implement by assigning equipped flights to earliest slot *of either type*



- Should grant greatest advantage to equipped flights, but may be inefficient

Compression method

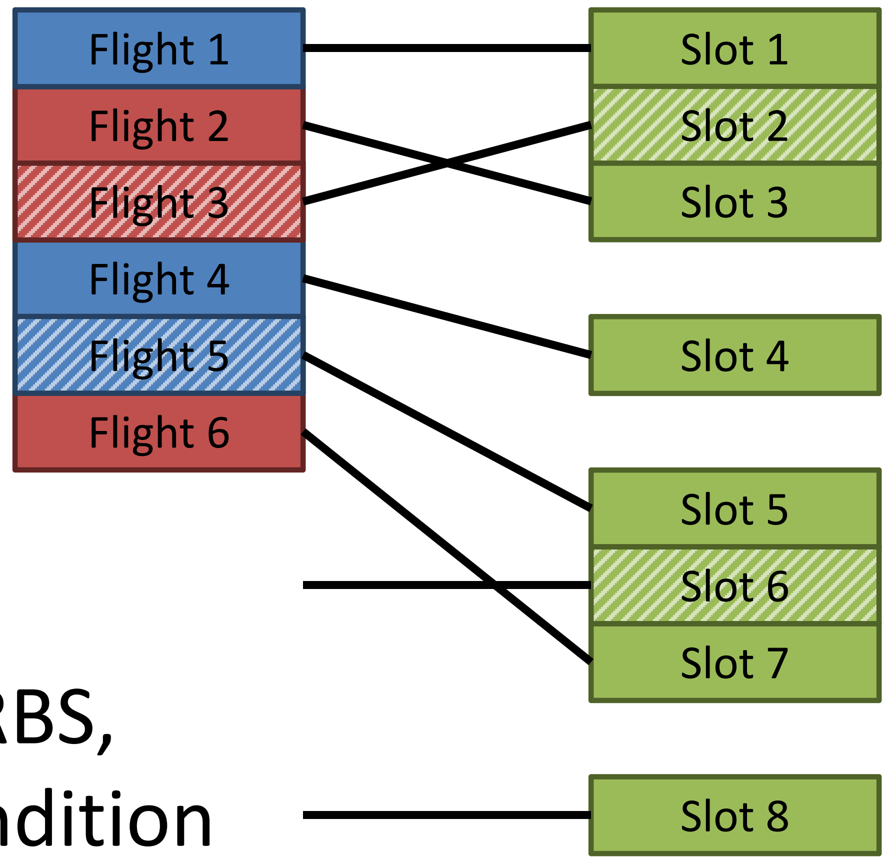
- Perform RBS for all flights using base slot set
- Add each enhanced slot, beginning with the earliest
  - Compression after moving first equipped flight to enhanced slot



- 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

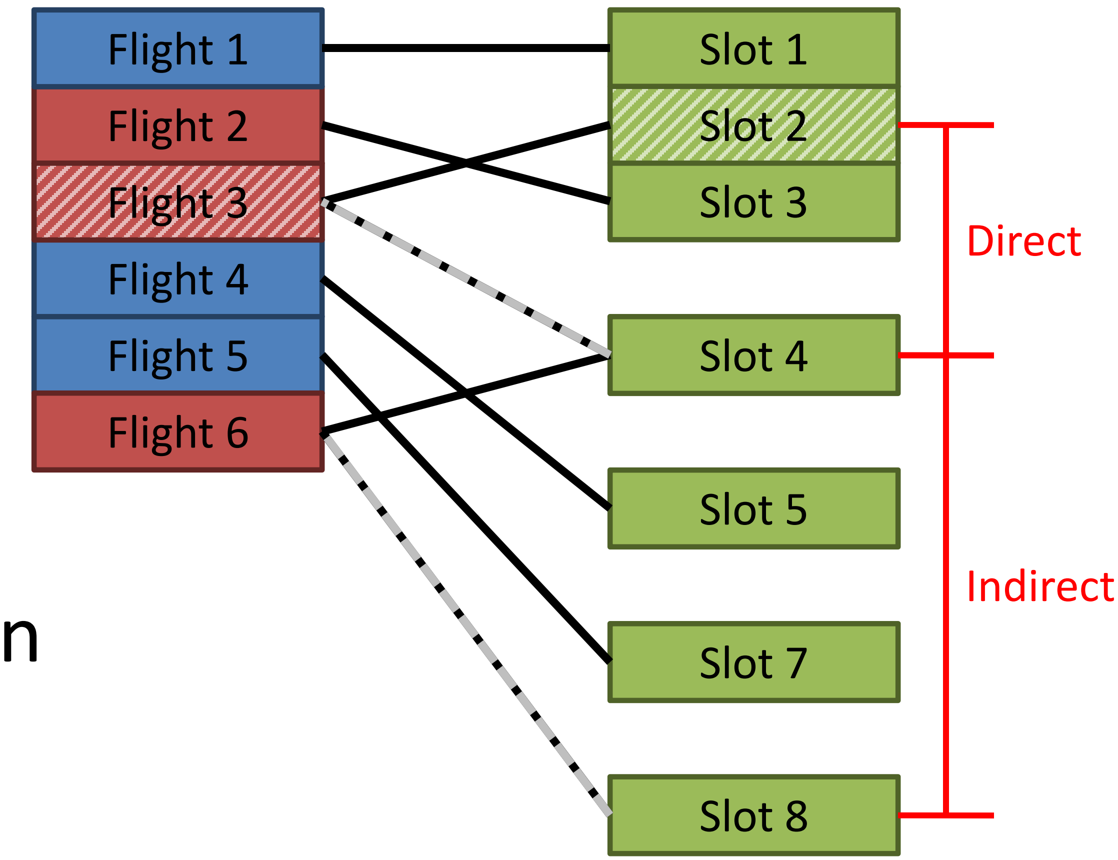
1. How should ***indirect benefits*** resulting from increased capacity be distributed?

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?

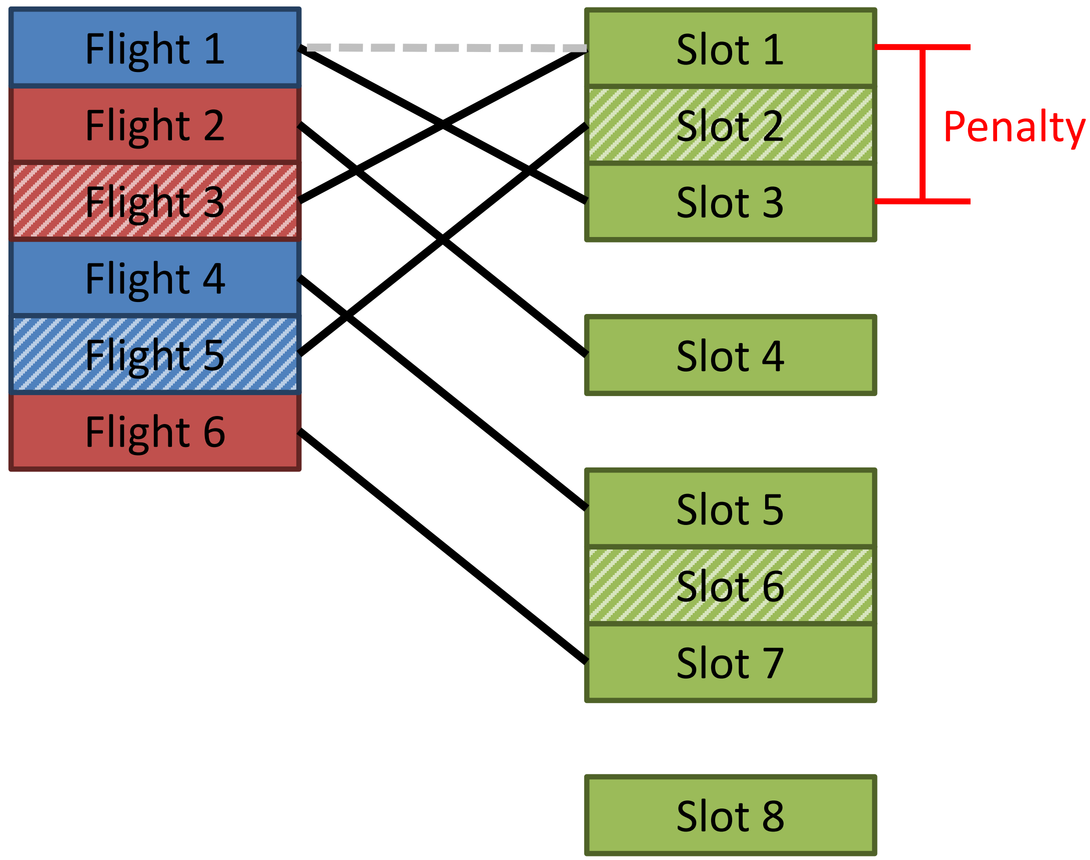
Distribution of indirect benefits

- 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

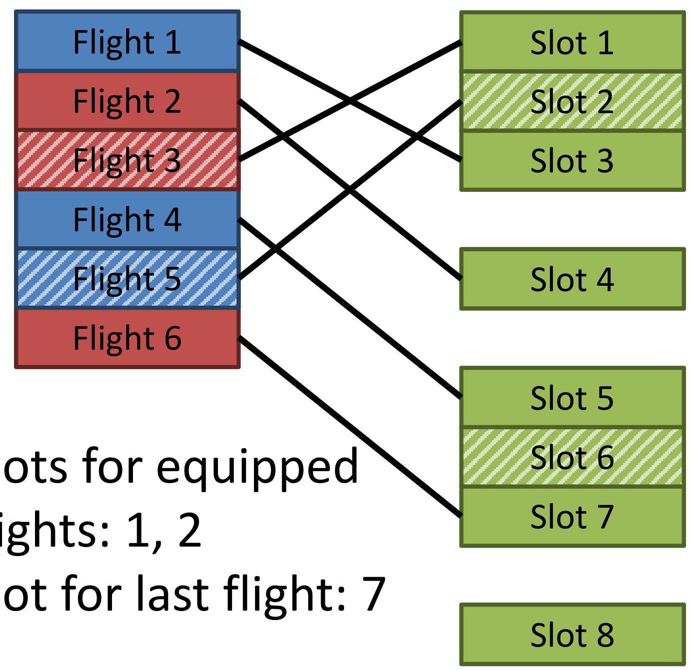
- Some unequipped flights may be assigned later than RBS time to accommodate equipped flights
  - Only exemption method susceptible



Throughput maximization

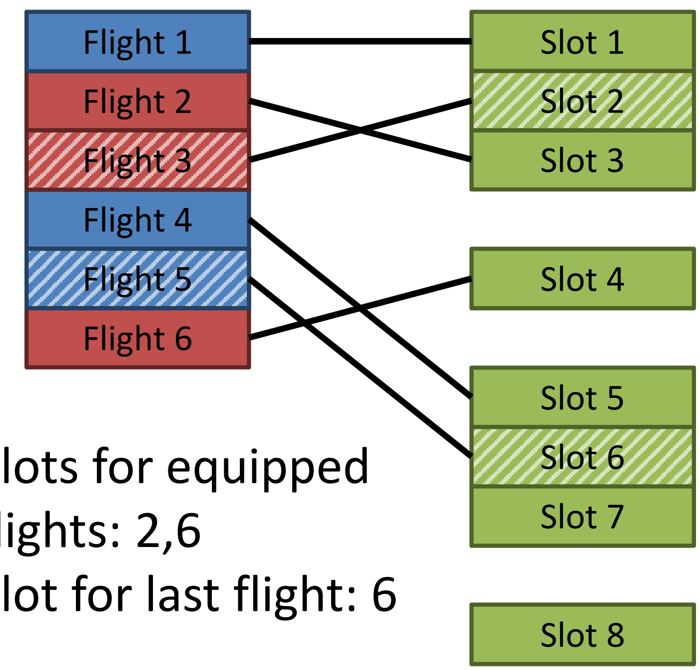
- A trade may exist between maximizing throughput and prioritizing equipped flights

Exemption



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

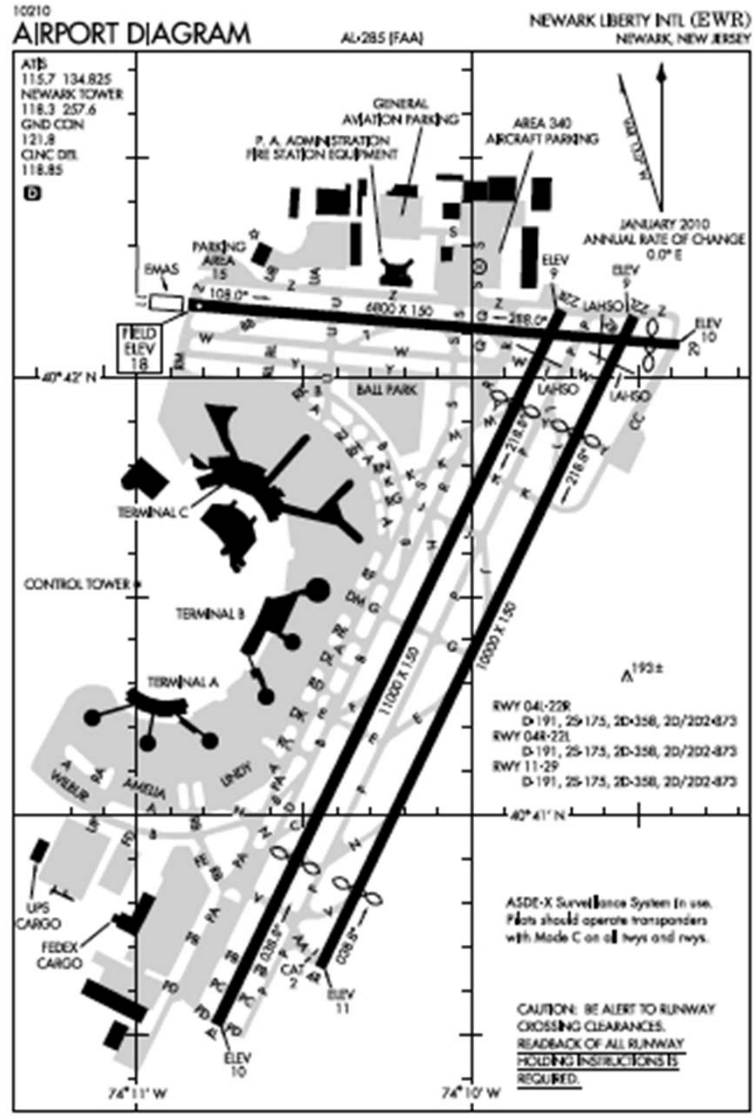
Compression



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

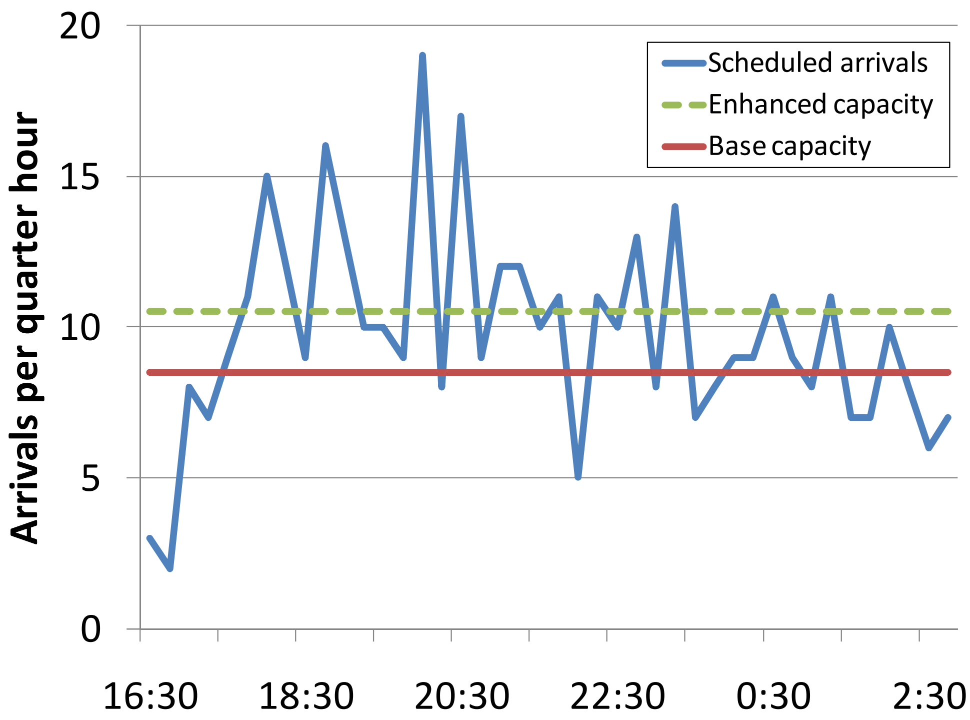
Case study background

- 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



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

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

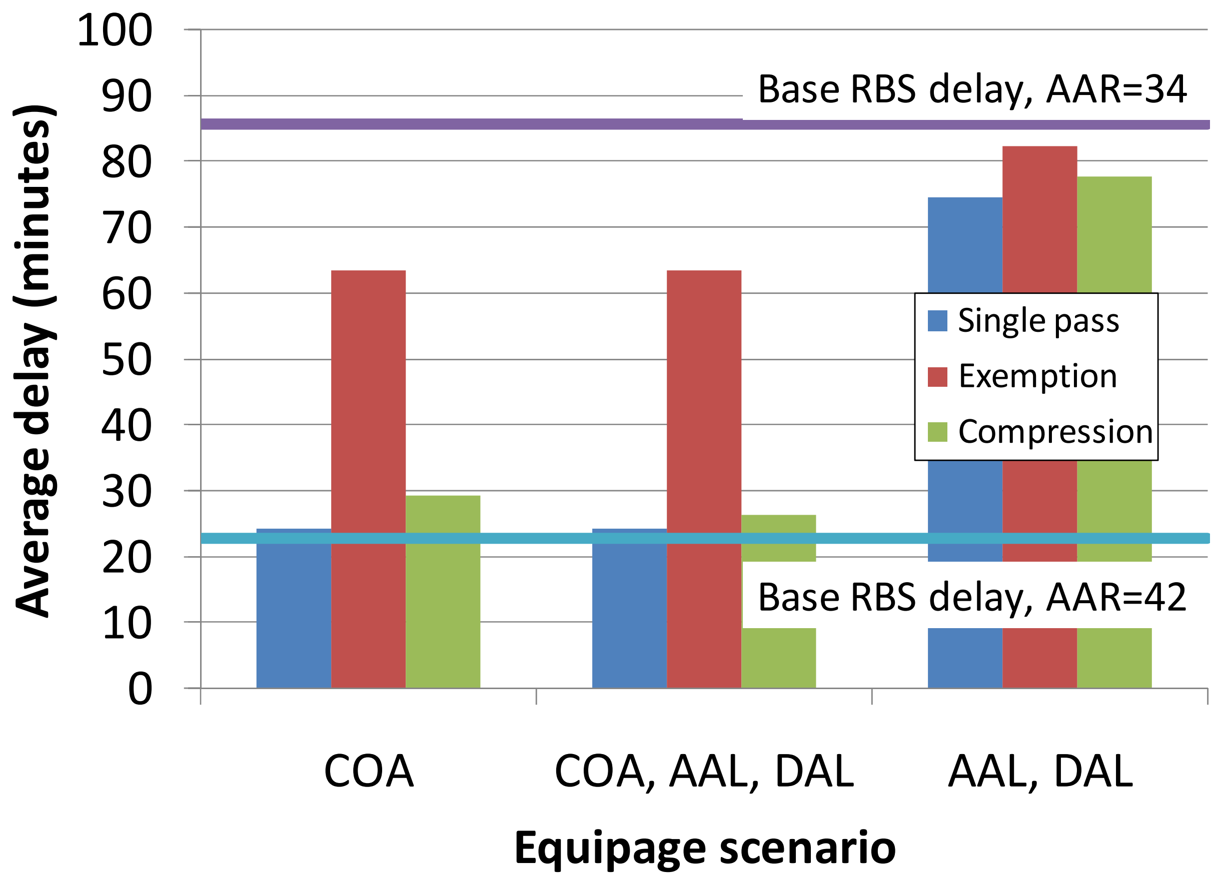
Equipage scenarios

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

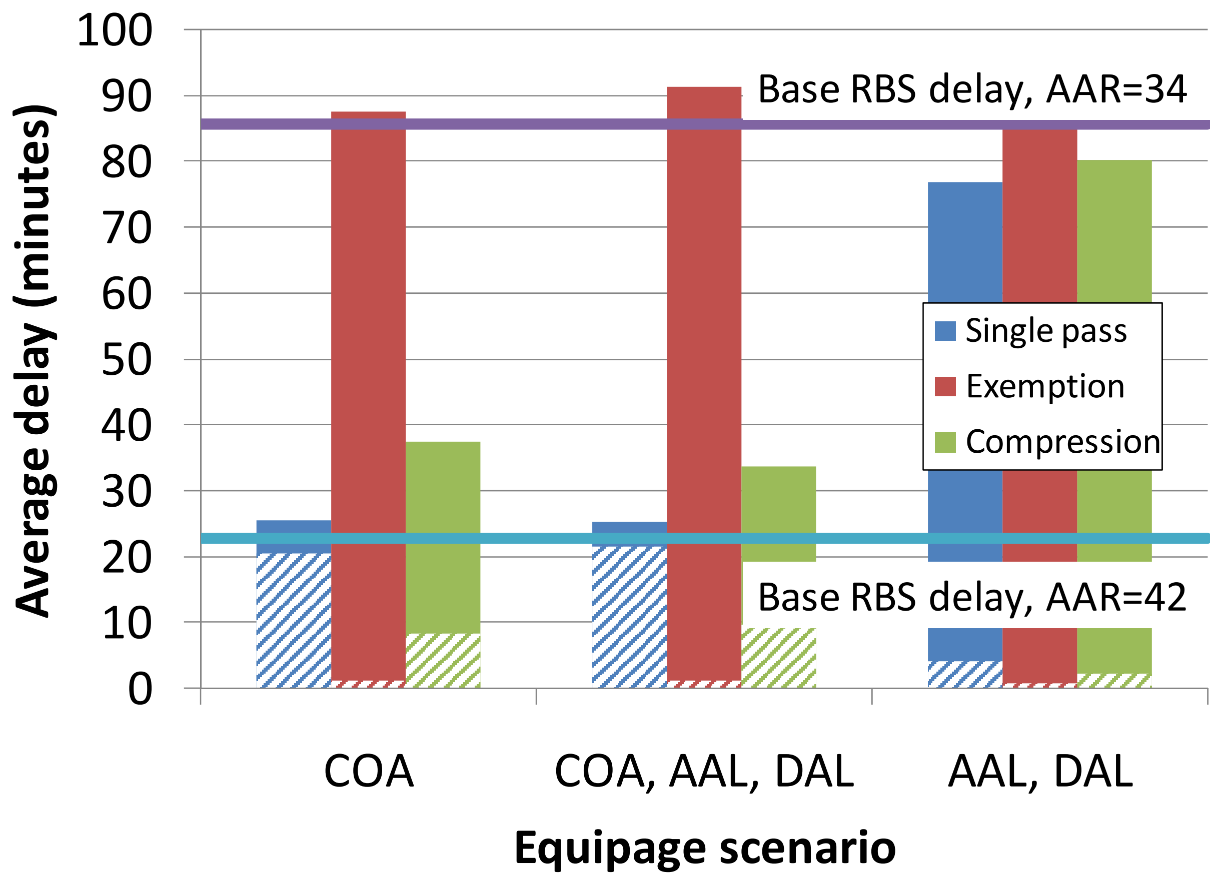
– Examine evolution of delays with increasing equipage levels

Analysis of results



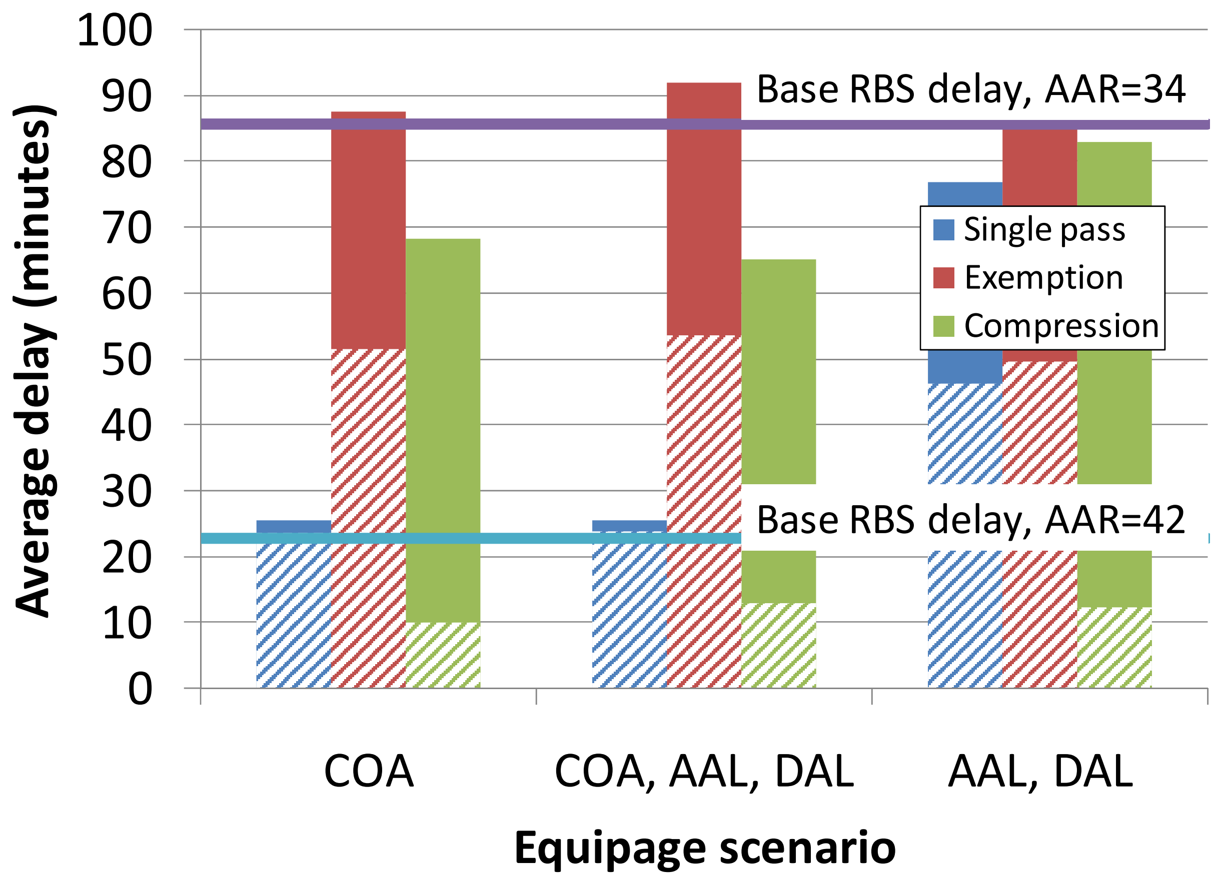
- Comparison of aggregate mean delays across methods and equipage scenarios

Analysis of results



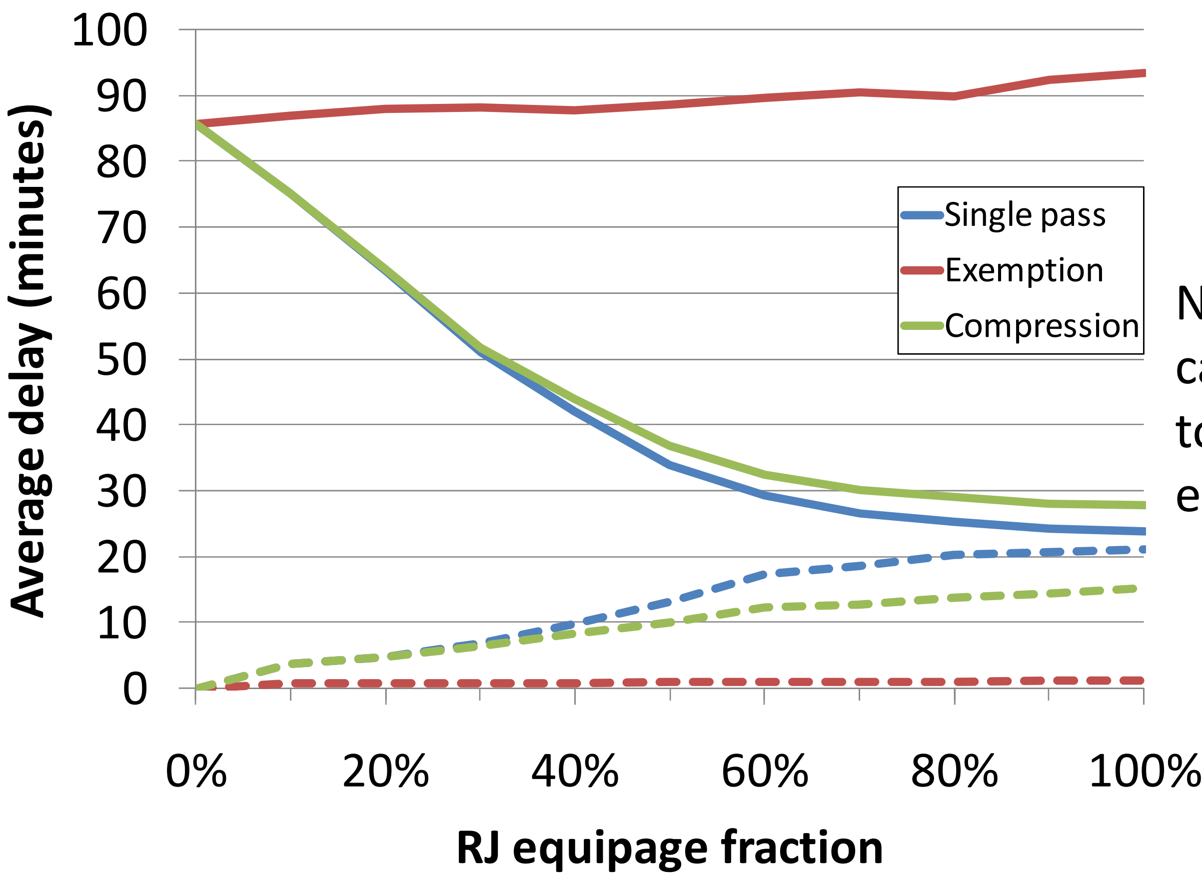
- Comparison of aggregate mean delays across methods and equipage scenarios for equipped and unequipped ***flights***

Analysis of results



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

Analysis of results



No particular carrier assumed to have equipped

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

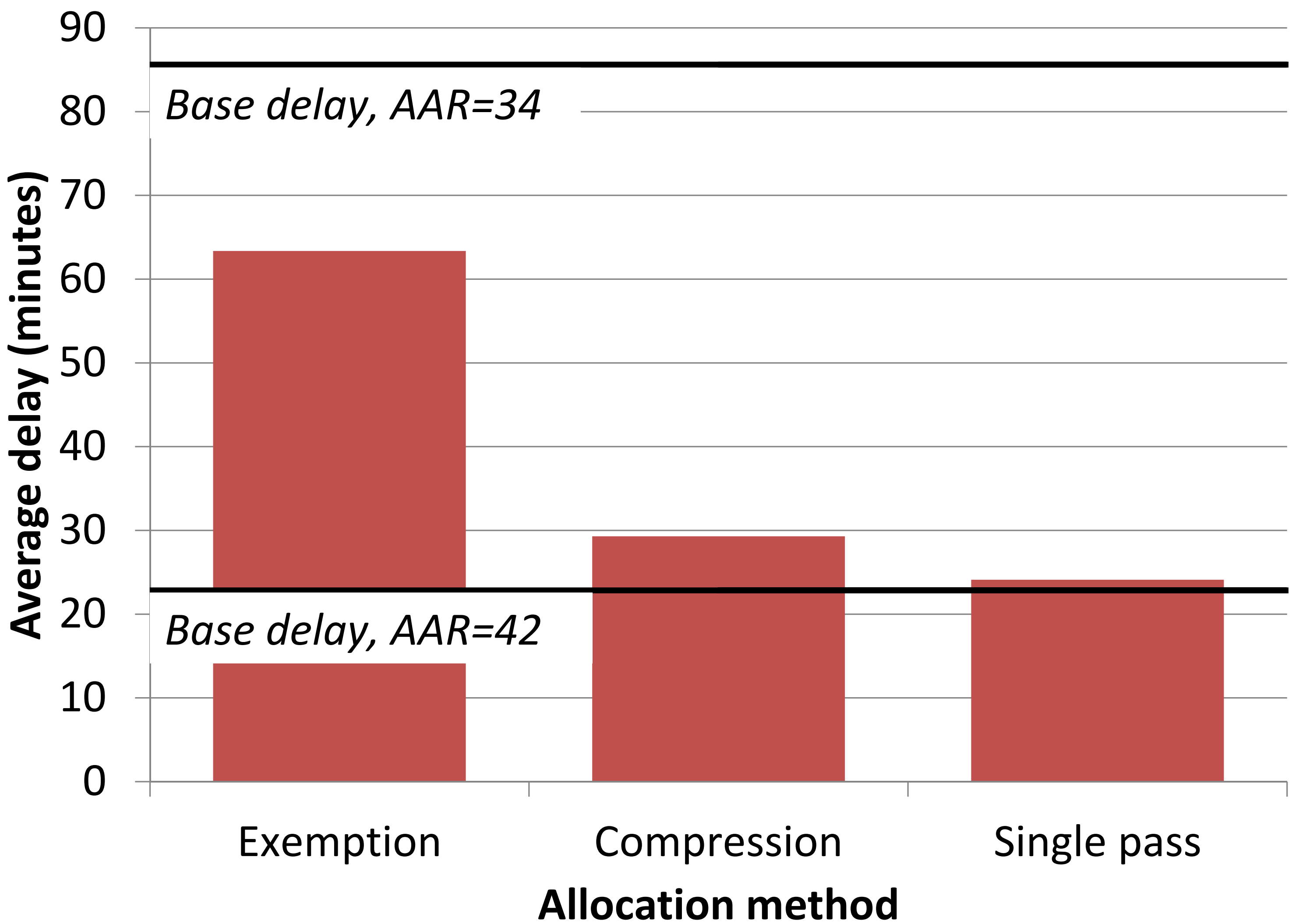
Conclusions

NEXTOR

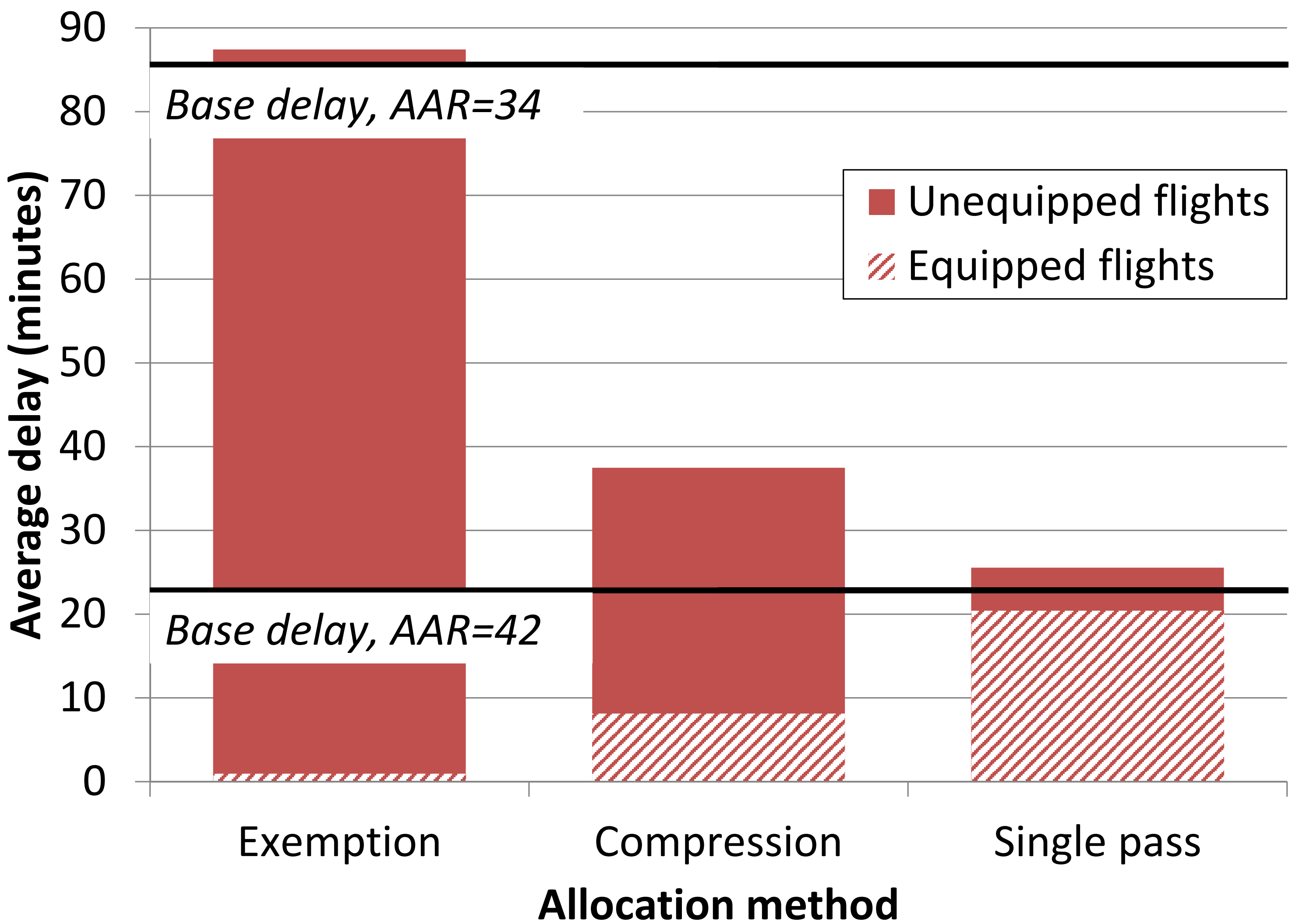
- Reasonable that BEBS may be used to introduce and distribute benefits of Next Gen
- Important to consider policy implications of method used for flight prioritization
  - Carefully directed benefits may help to incentivize equipage
- Additional work to examine stability of results suggests little dependency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

Other material

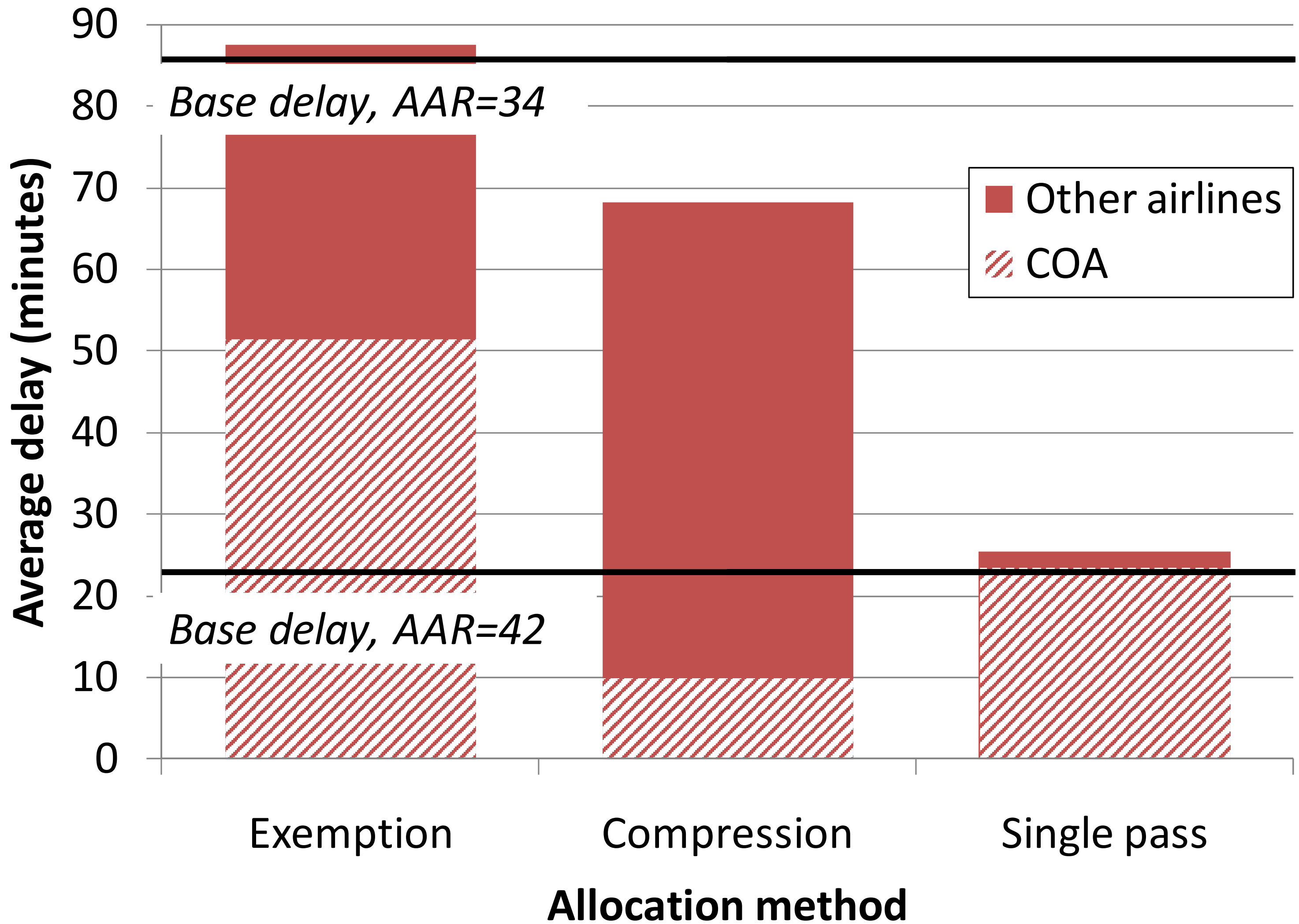
Comparison of delays



Comparison of delays by equipage



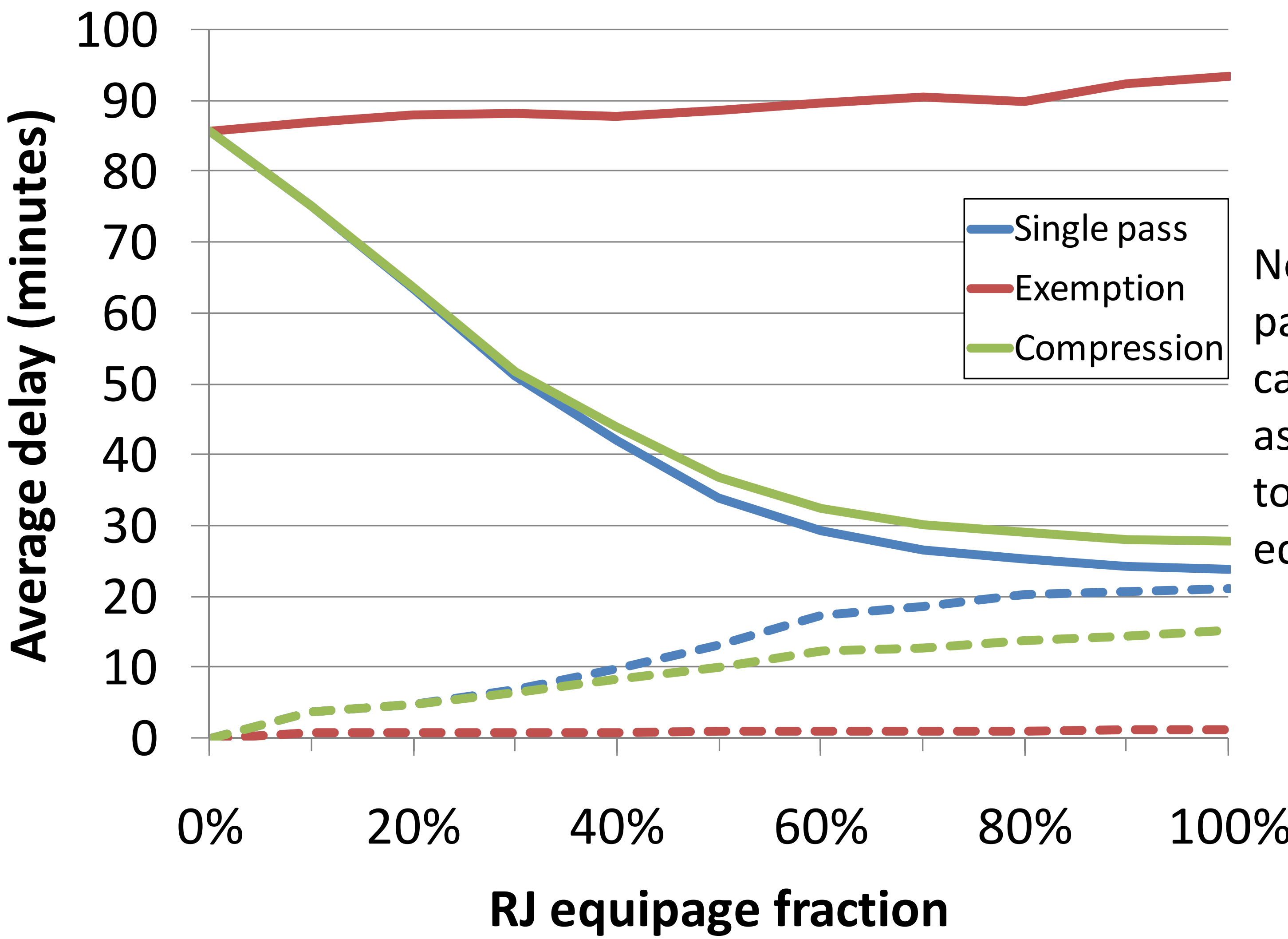
Comparison of delays by carrier



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



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