Improving Maintenance Robustness using a Route Adjustment Tail Assignment Problem

Guy Desaulniers[1] Stephen J. Maher[2] François Soumis[1]

[1] École Polytechnique de Montréal and GERAD,
Department of Mathematics and Industrial Engineering, Montréal, Canada.

[2] Zuse Institute Berlin
Berlin, Germany.

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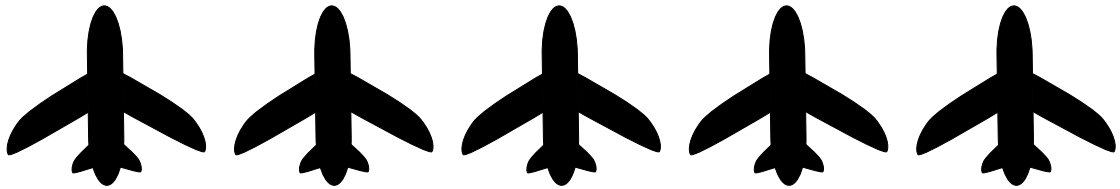
The tail assignment problem



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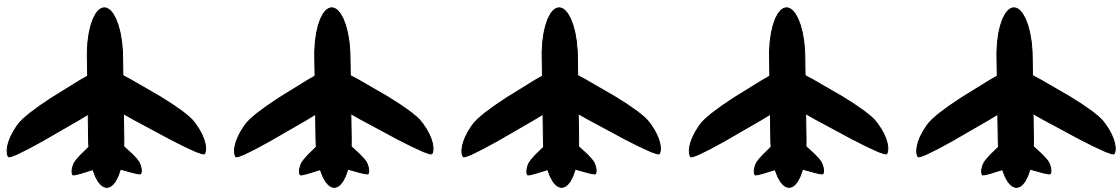

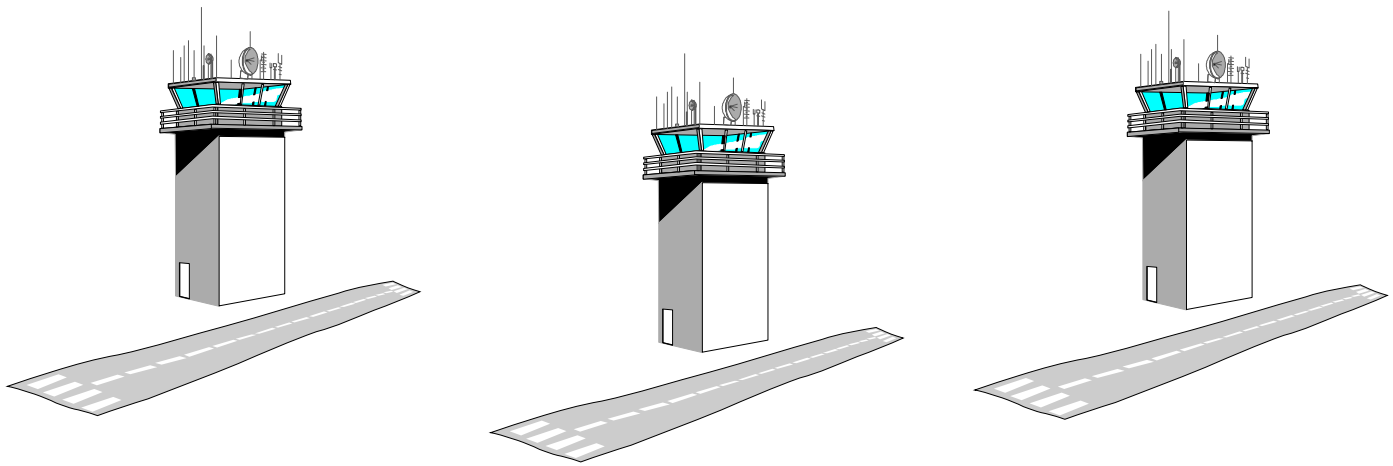

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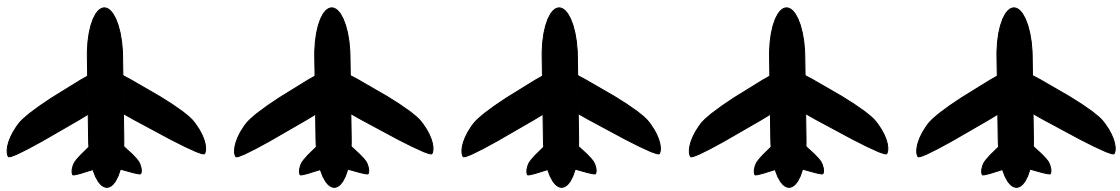

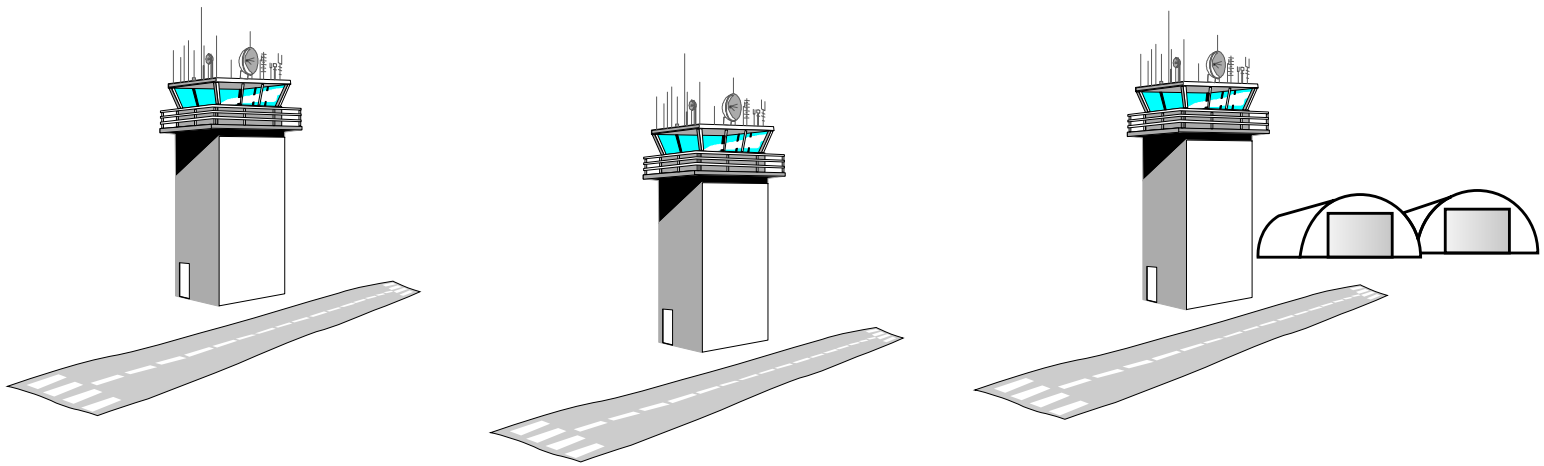

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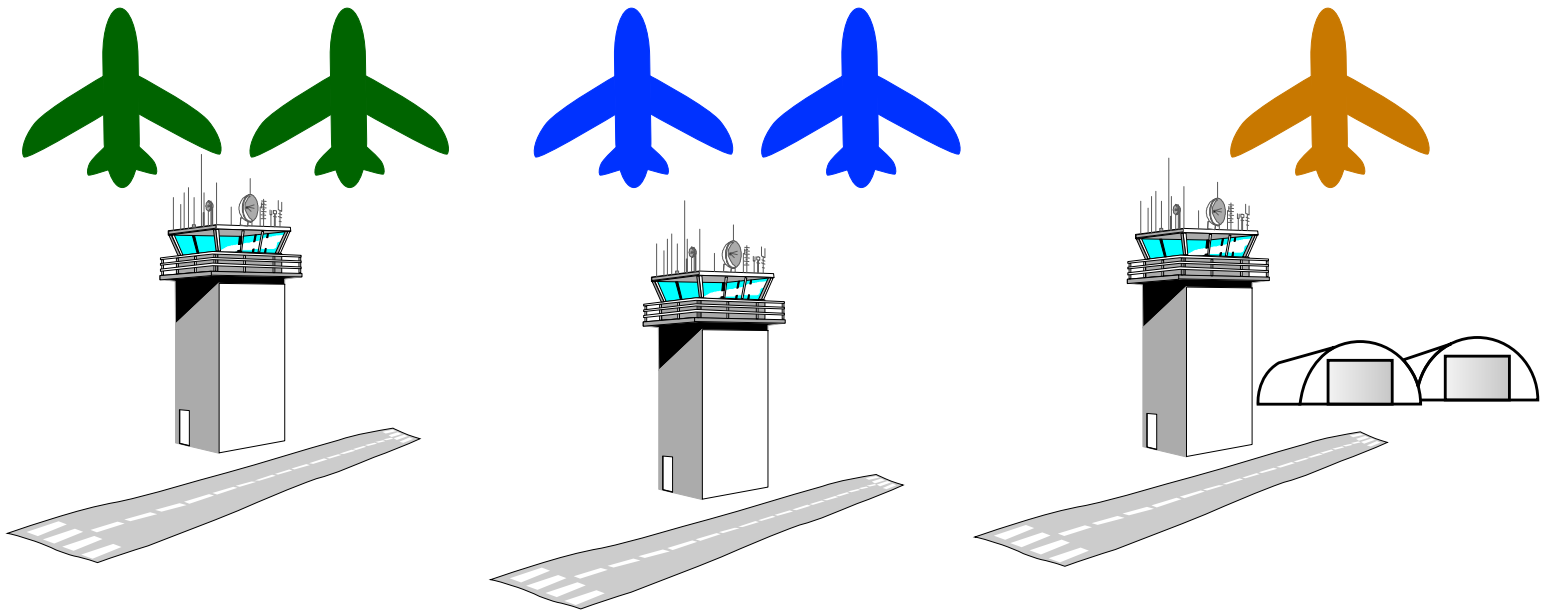

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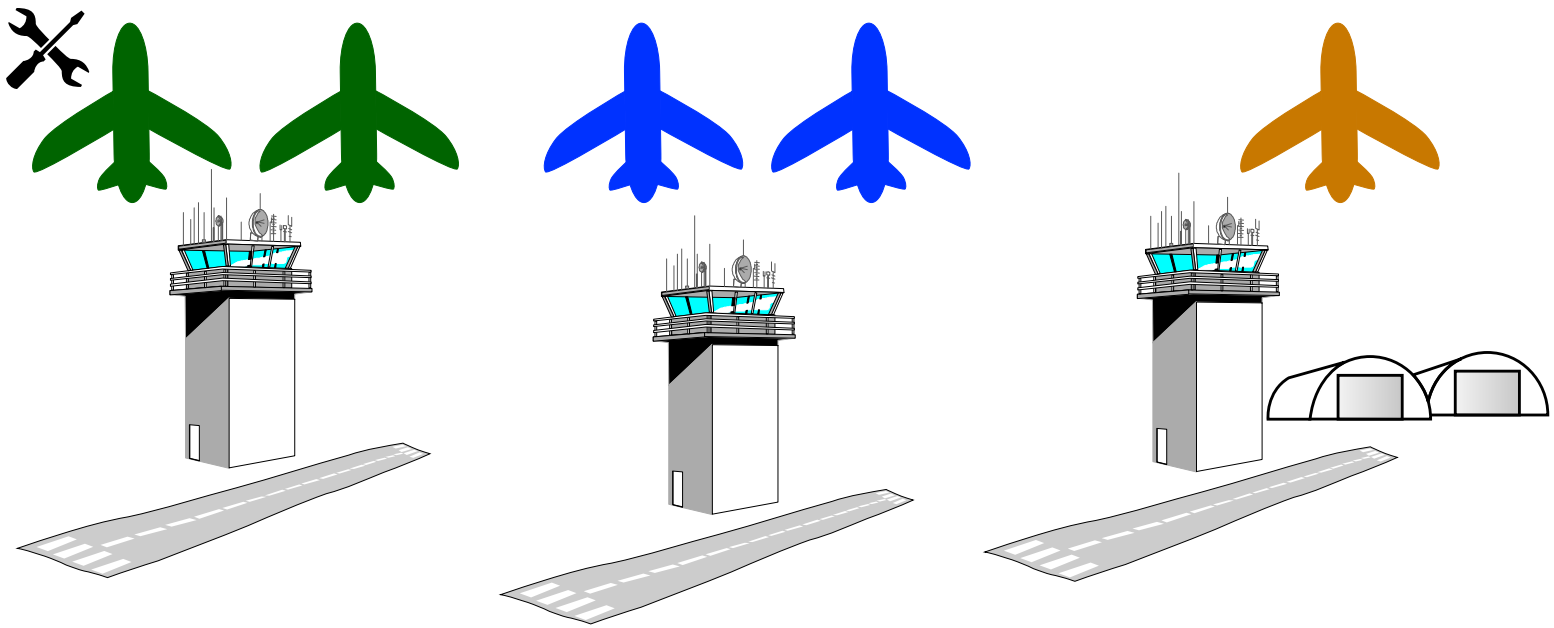

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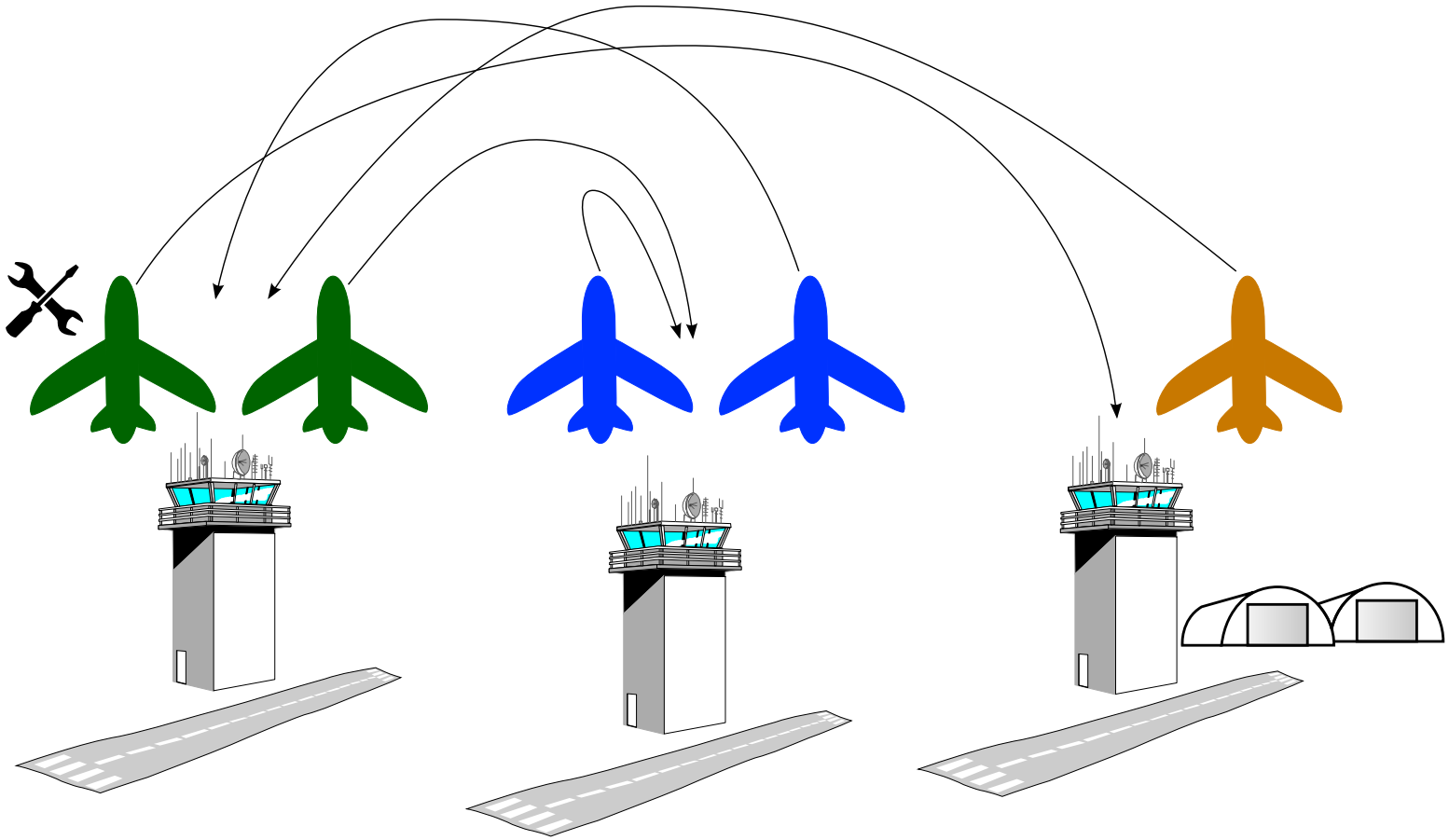

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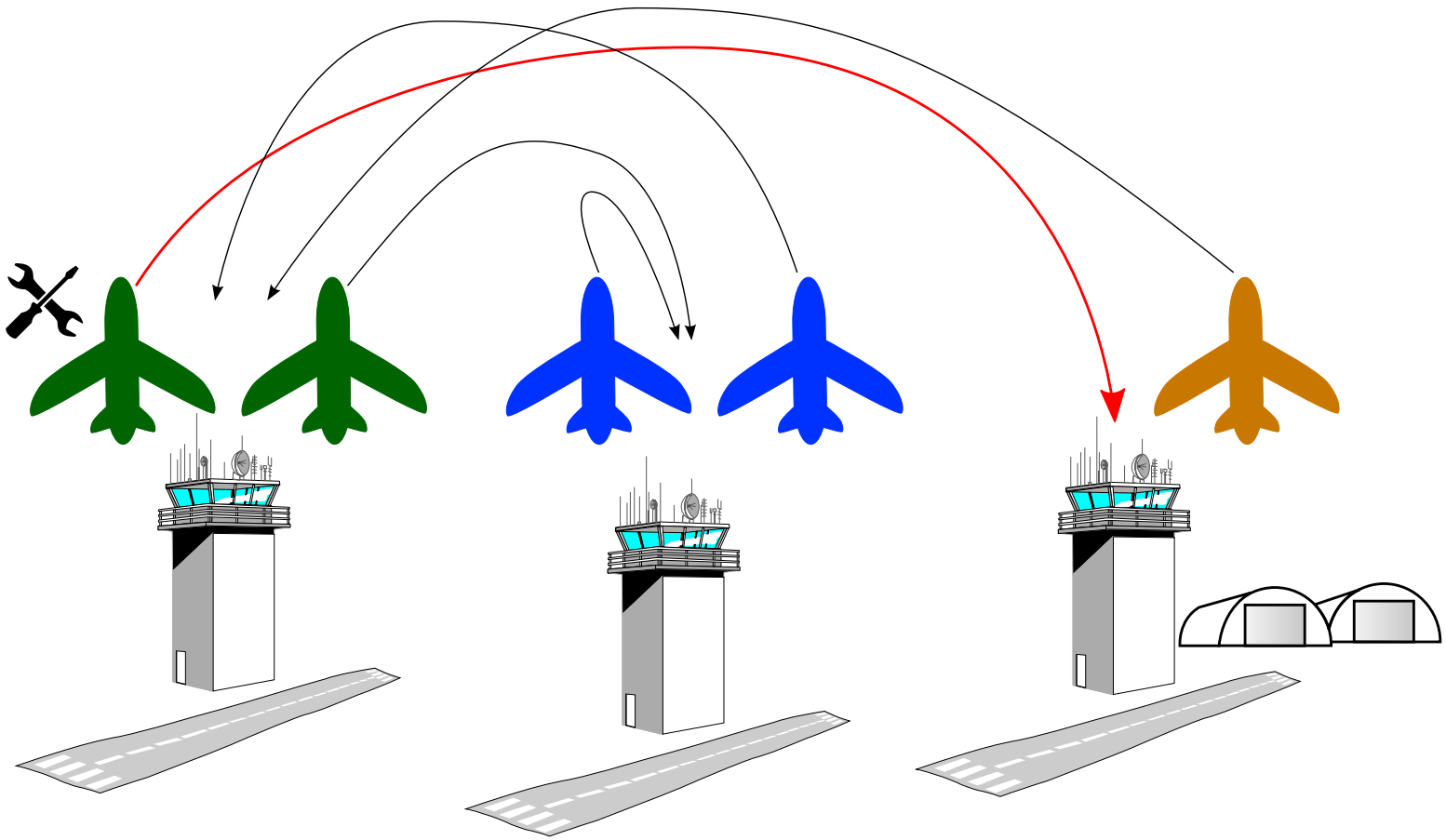
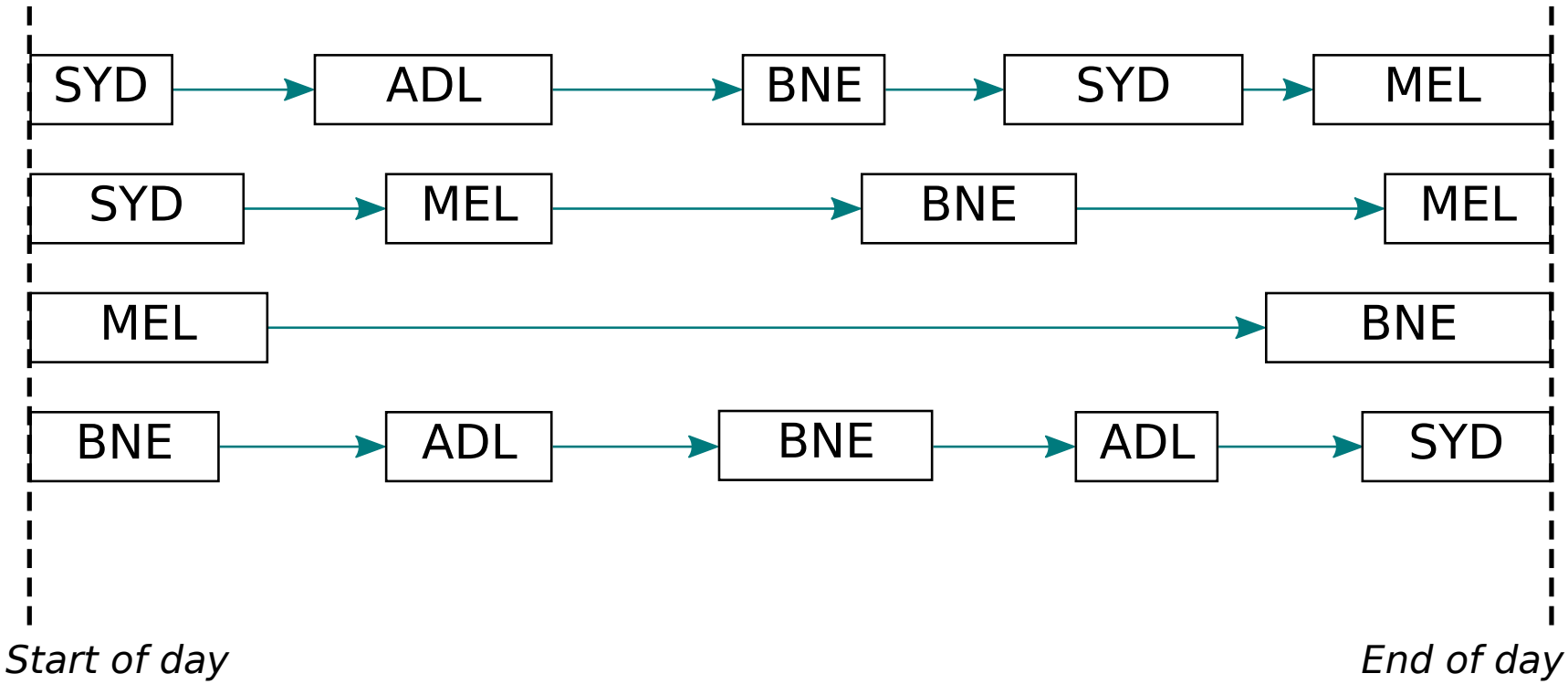


Line-of-flight



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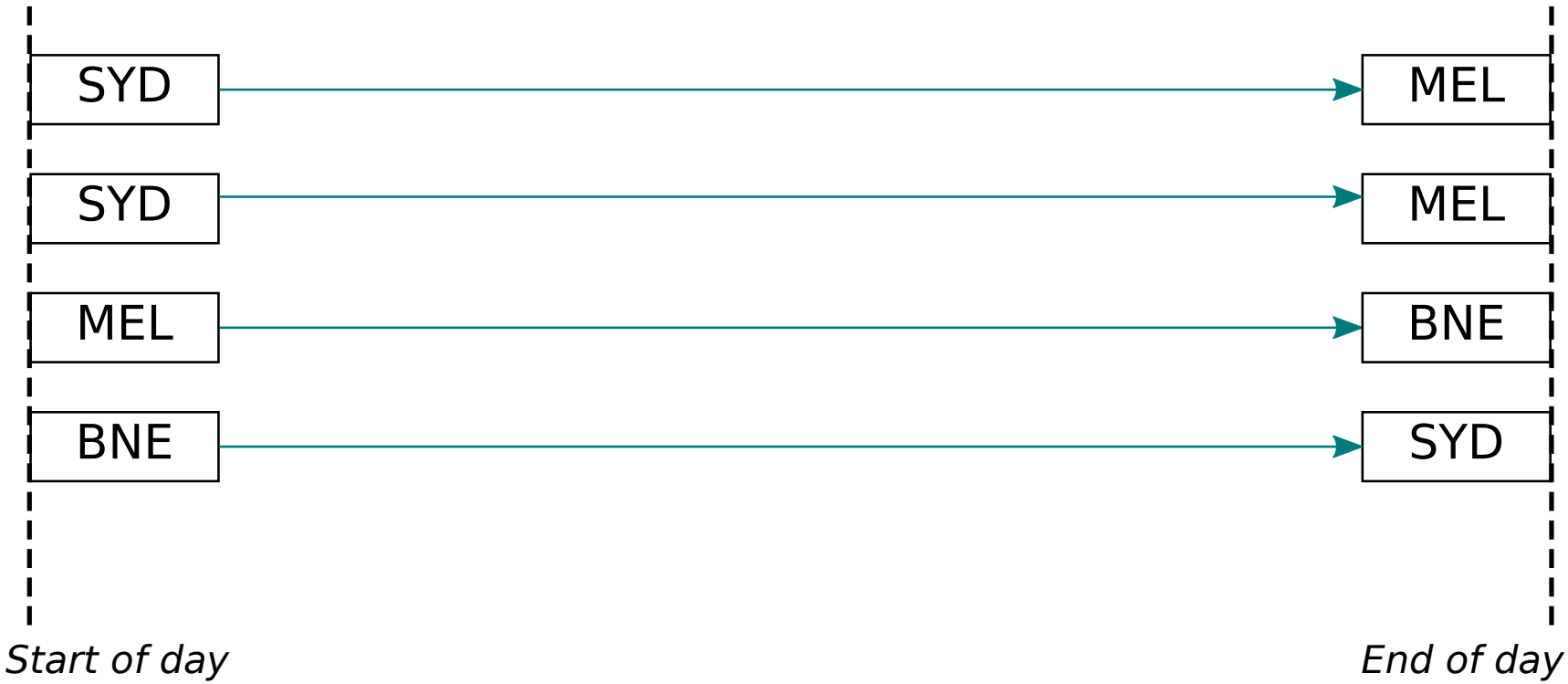


Fixed line-of-flight input

Benefits

- Separate aircraft routing and tail assignment problems.
- Results in a simple problem for the tail assignment.

Difficulties

- Unable to plan for all realisations of the maintenance schedule and aircraft locations.
- No recourse when disruptions occur.
- May result in aircraft not satisfying maintenance requirements.

Outline

Problem definition

The Tail Assignment Problem

The assignment of LOFs to aircraft, while:

- minimising the number of maintenance misalignments of days one, two and three,
- minimising the cost associated with any gate assignment changes.

Definitions

Maintenance misalignment

Occurs if an aircraft requiring maintenance on day n is unable to enter a maintenance station at the end of day n due to the available set of LOFs.

Gate assignment changes

Either:

- change to the departure gate of the first flight for an LOF,
- change to the aircraft gate location to operate the first flight of an LOF.

Maintenance misalignments

Day-one

- Introduce a constraint with slack variable to assign maintenance critical aircraft an MLOF.

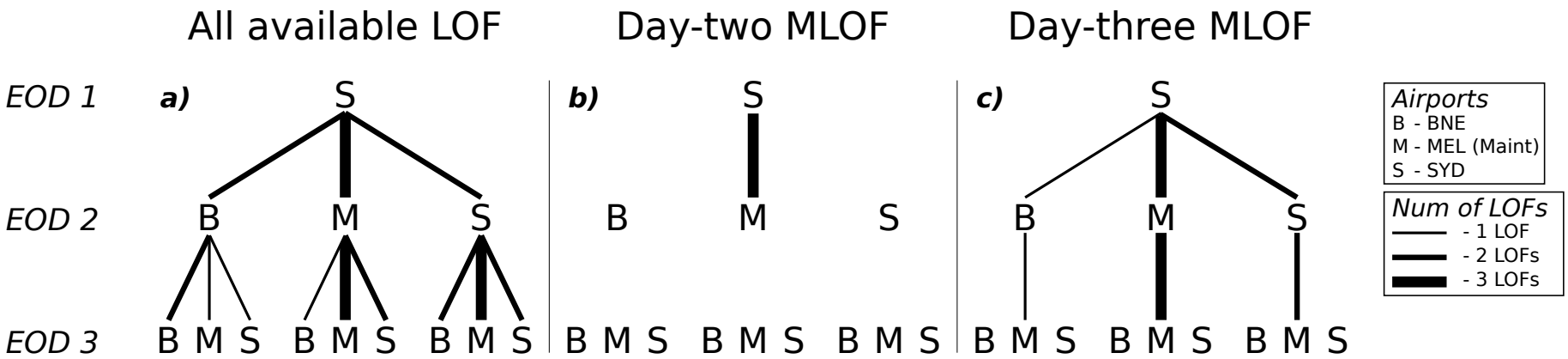
Day-two

- Introduce look-ahead constraint.
- Count the number of terminating maintenance critical aircraft.
- Ensure this does not exceed the available maintenance routes on day two.

Day-three

- Introduce look-ahead constraint.
- Count the number of terminating maintenance critical aircraft.
- Ensure this does not exceed the available paths to maintenance.
- Ensure that the assigned paths through each base does not exceed the available maintenance routes on day three.

Day-two and -three maintenance misalignments



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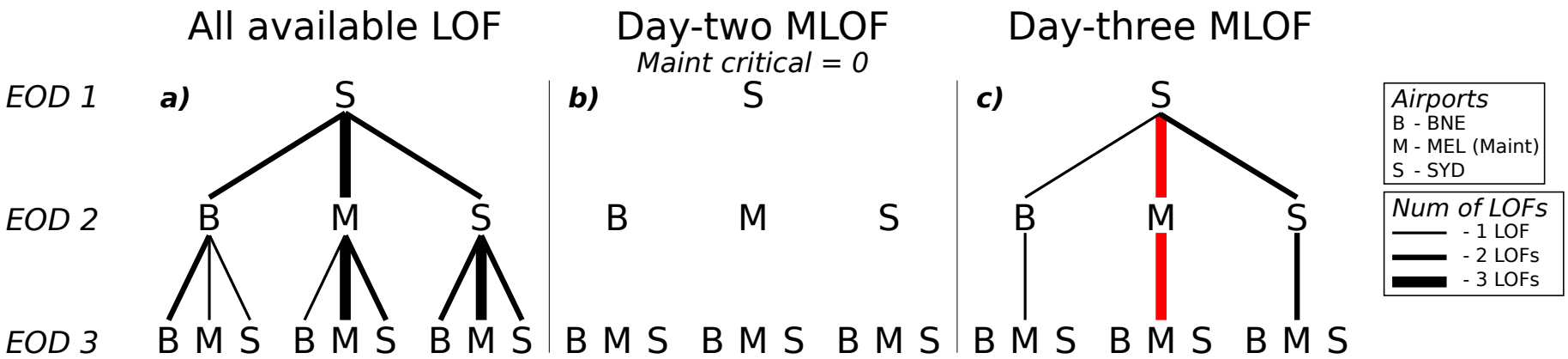

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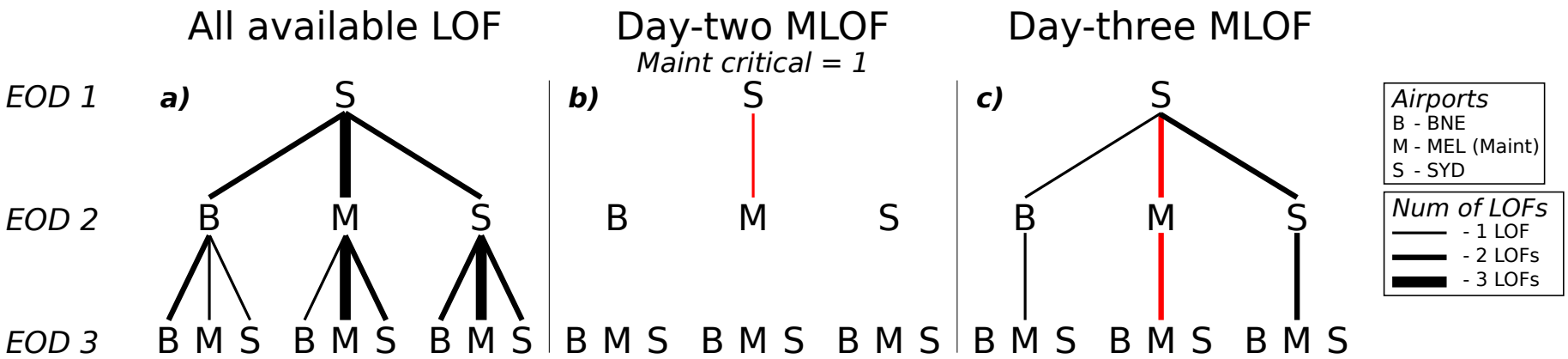
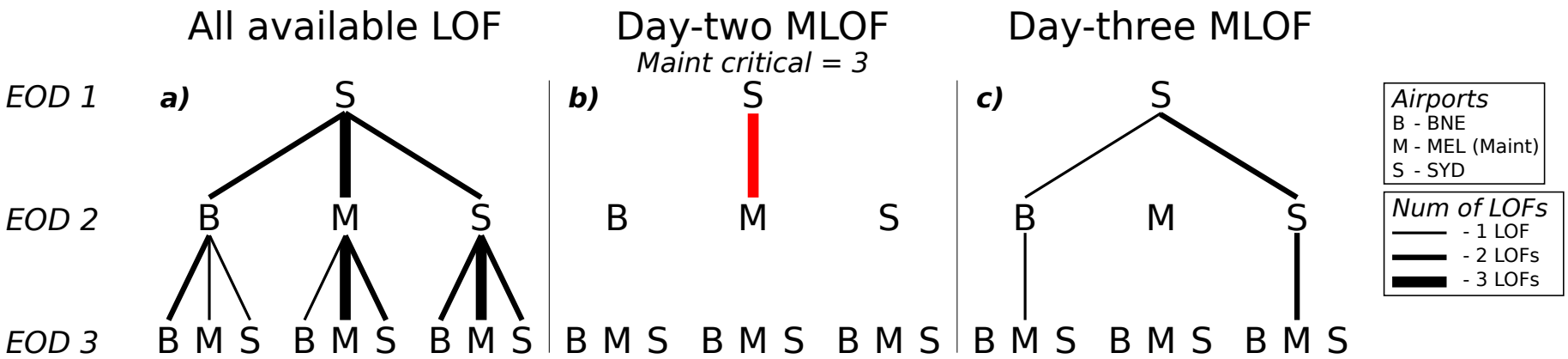
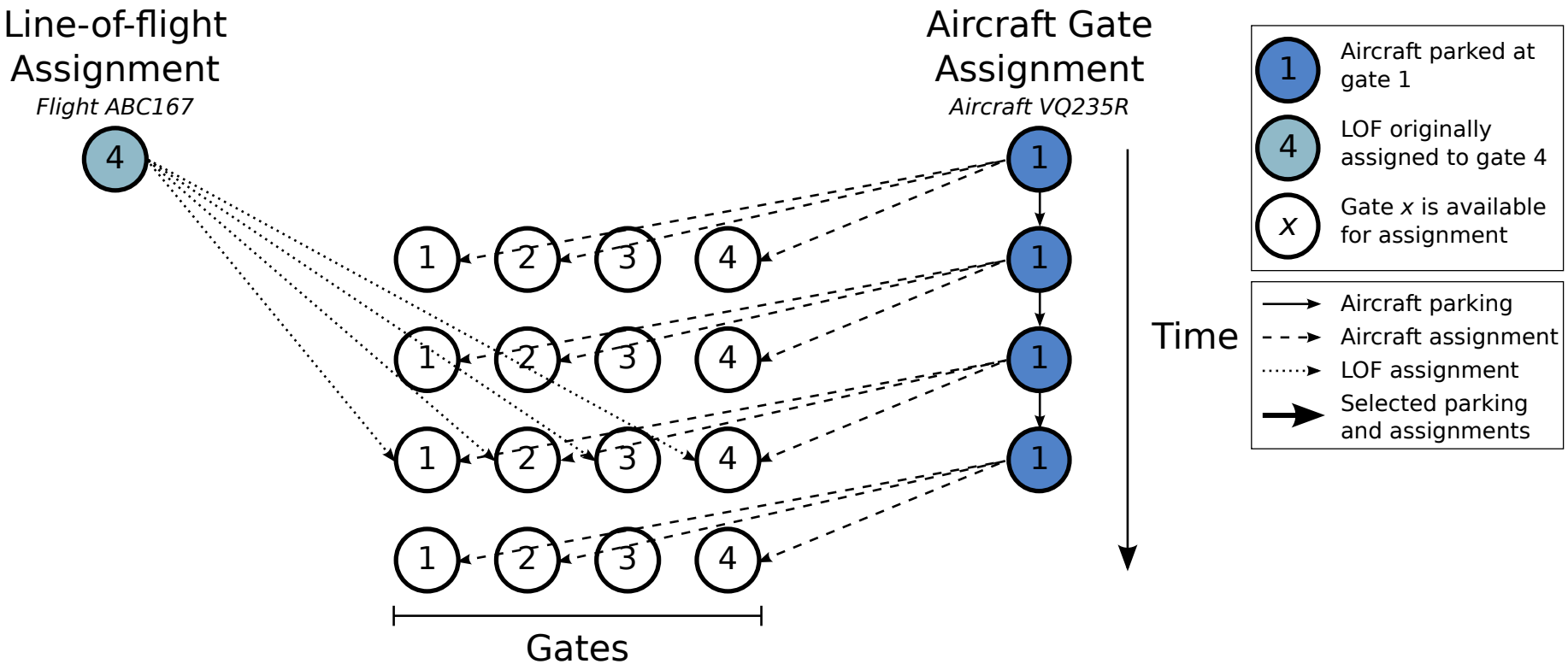


Day-two and -three maintenance misalignments



Gate assignment



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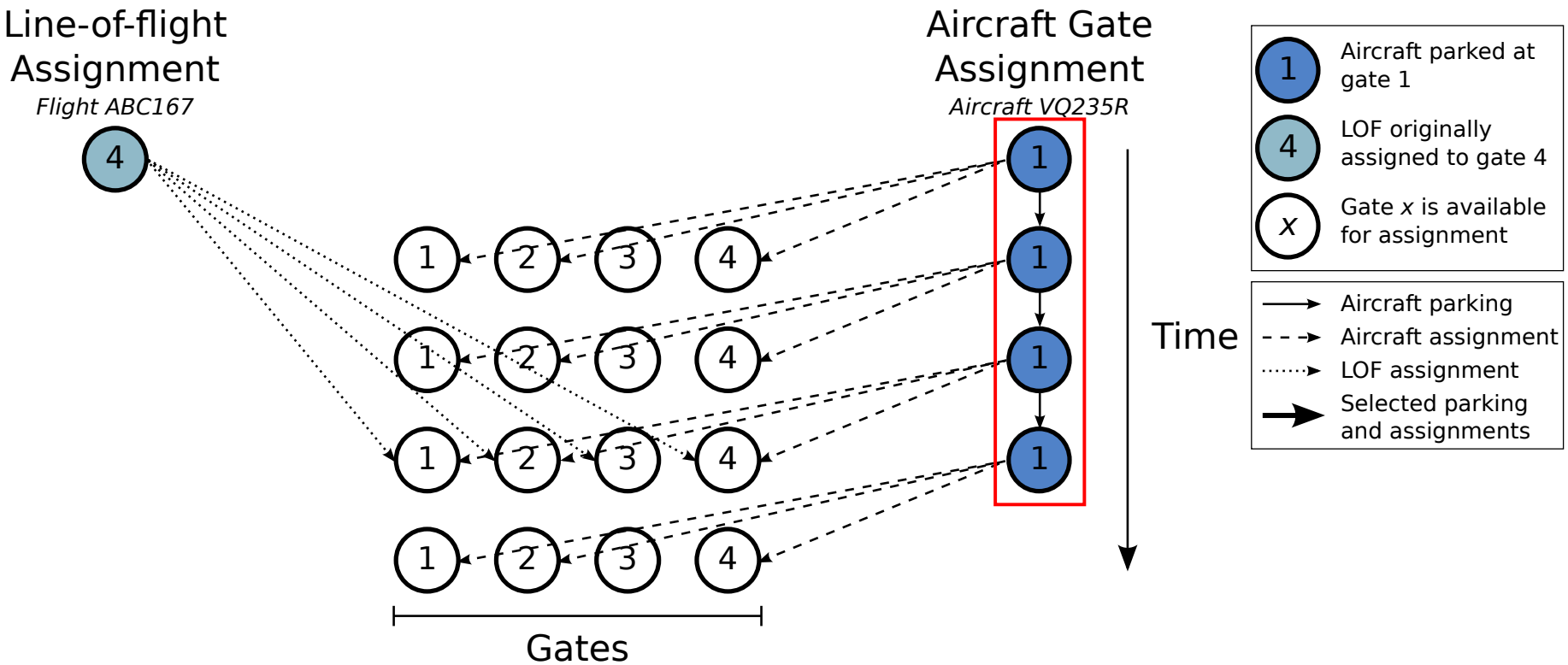

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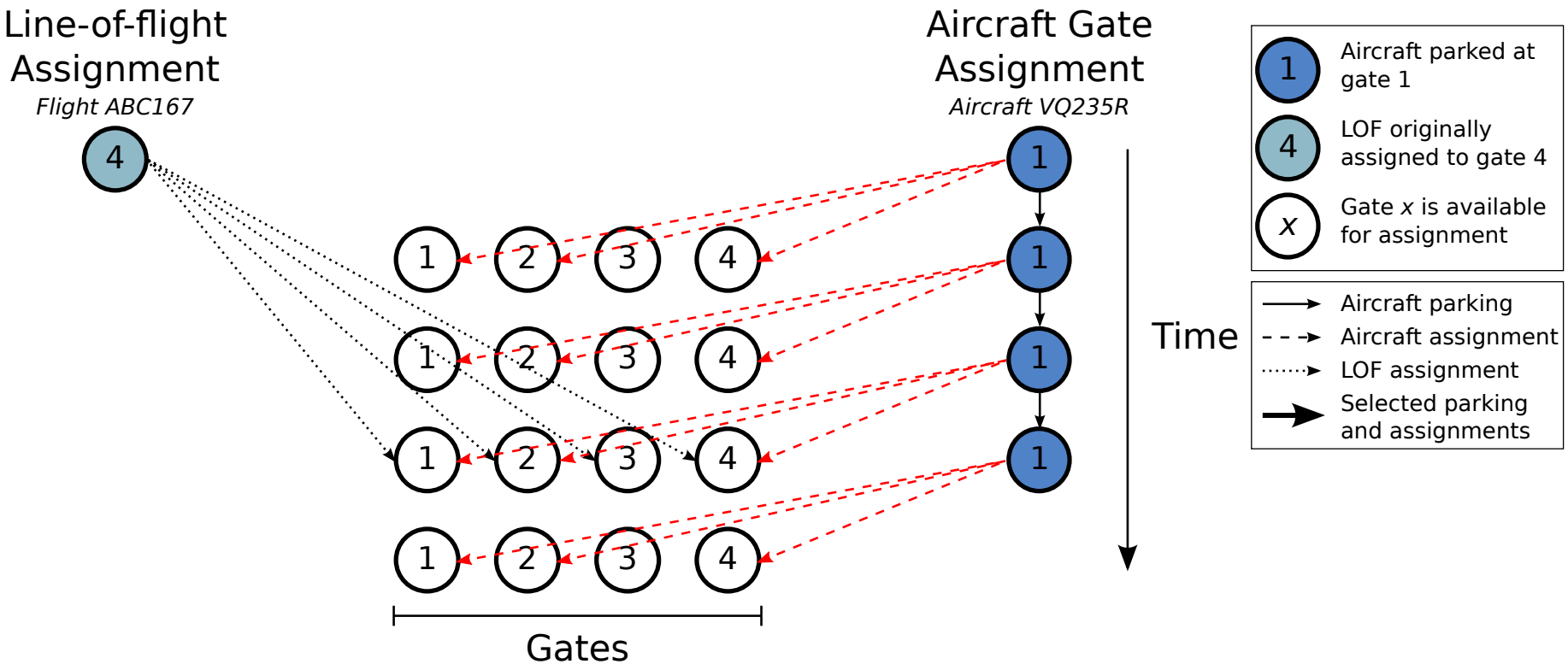

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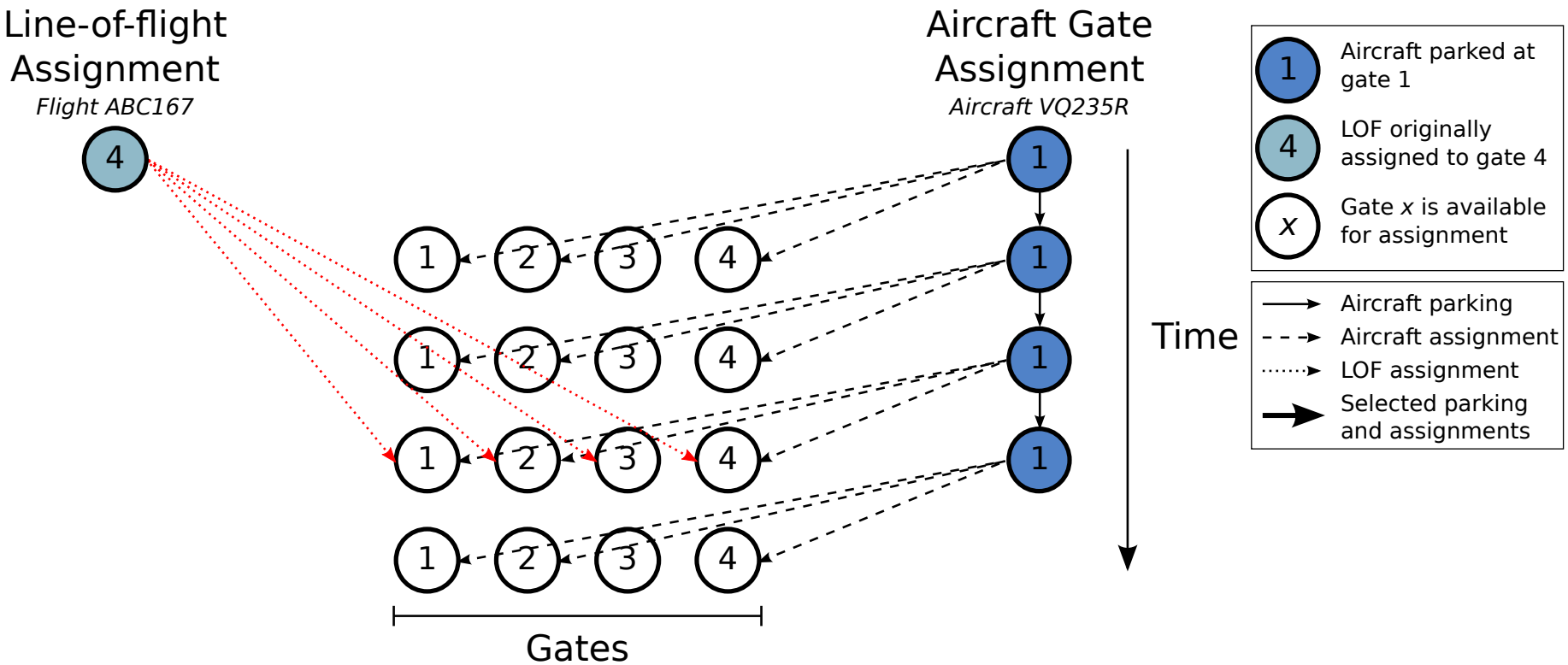
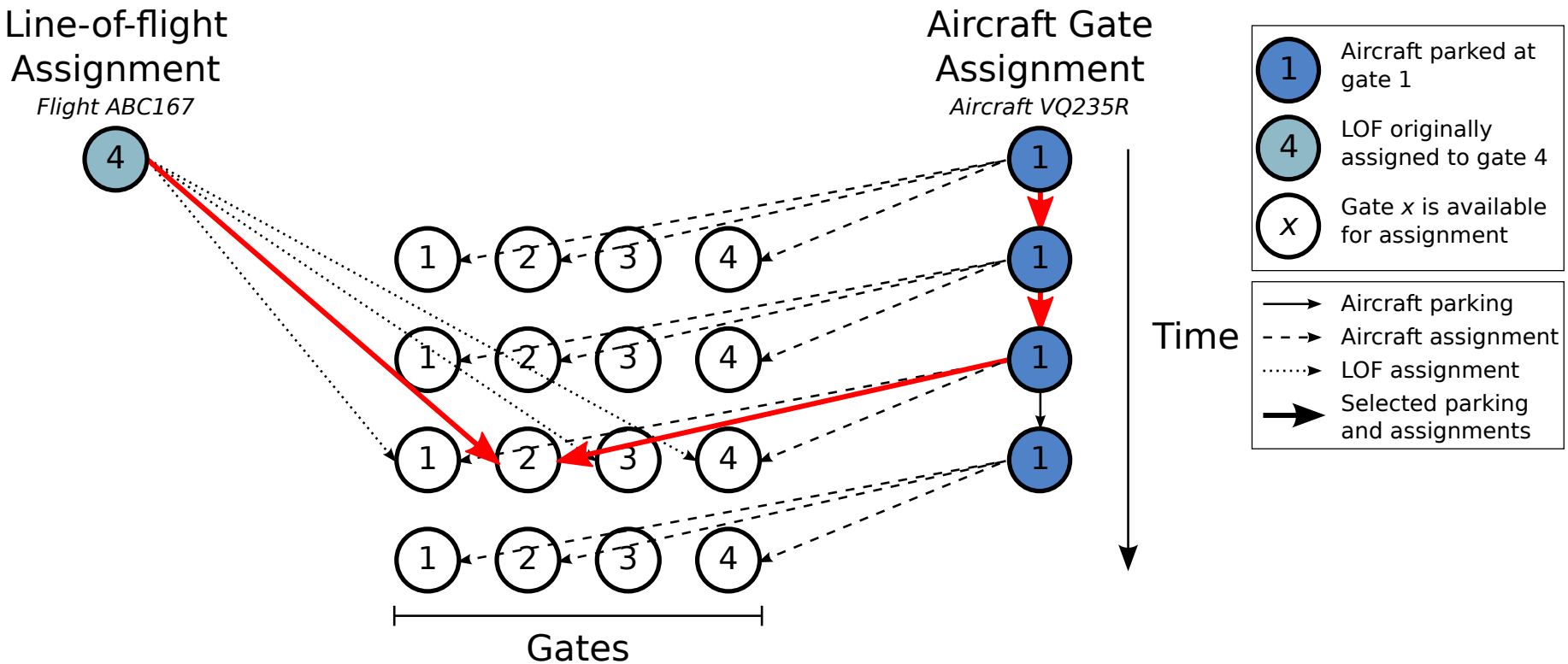


Gate assignment



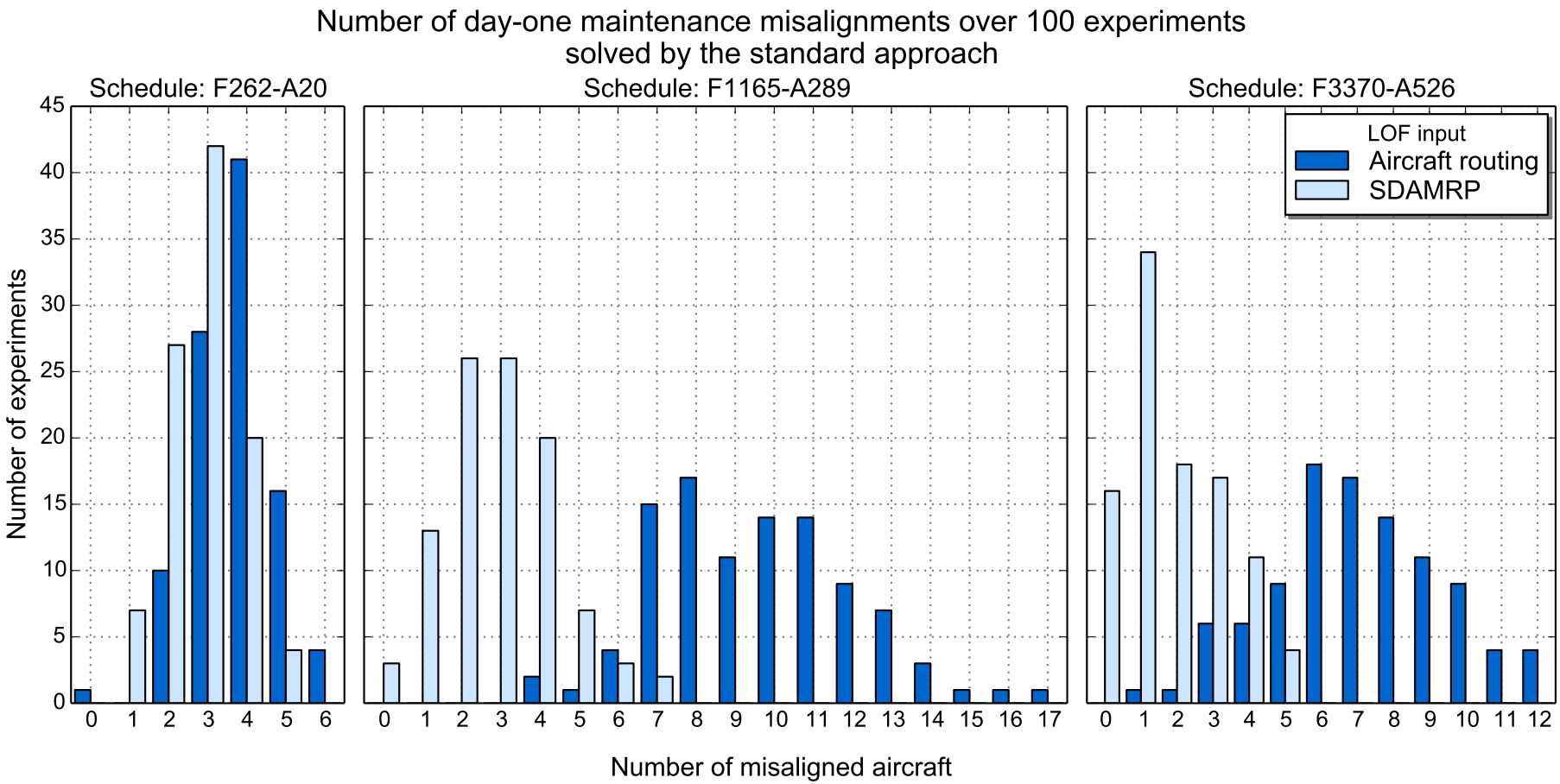
Airline Flight Schedule Data

- 2 sets of lines-of-flight collected from Maher et al. (2014).
  - Aircraft routing
  - One-day routes approach (SDAMRP)
- 3 different airline with different fleet sizes and maintenance setup.
- Diverse data provides a thorough evaluation of the model.

	F267-A49	F1165-A289	F3370-A526
Flights	267	1165	3370
Aircraft	49	289	526
Airports	20	97	73
Overnight bases	12	67	73
Maintenance bases	1	5	10

Table : Flight schedule details.

Day-one maintenance misalignments

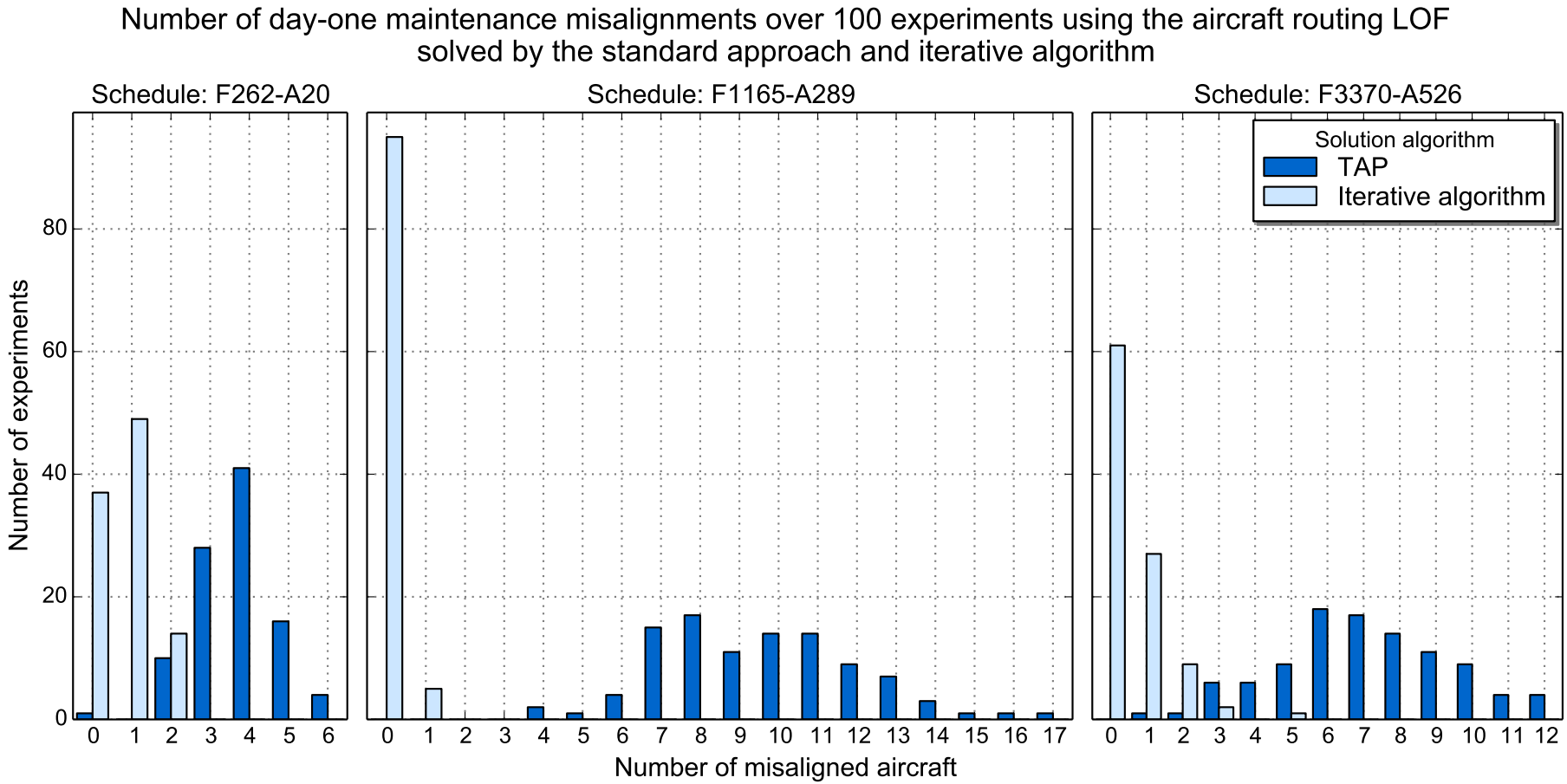


Iterative Algorithm

1. Solve the tail assignment problem.
2. Check
   - First run: If misalignments exists, select aircraft for route adjustment,
   - Other runs: If *improvement* occurs, update selected aircraft.
3. Solve route adjustment problem.
4. Update lines-of-flight for the tail assignment problem.

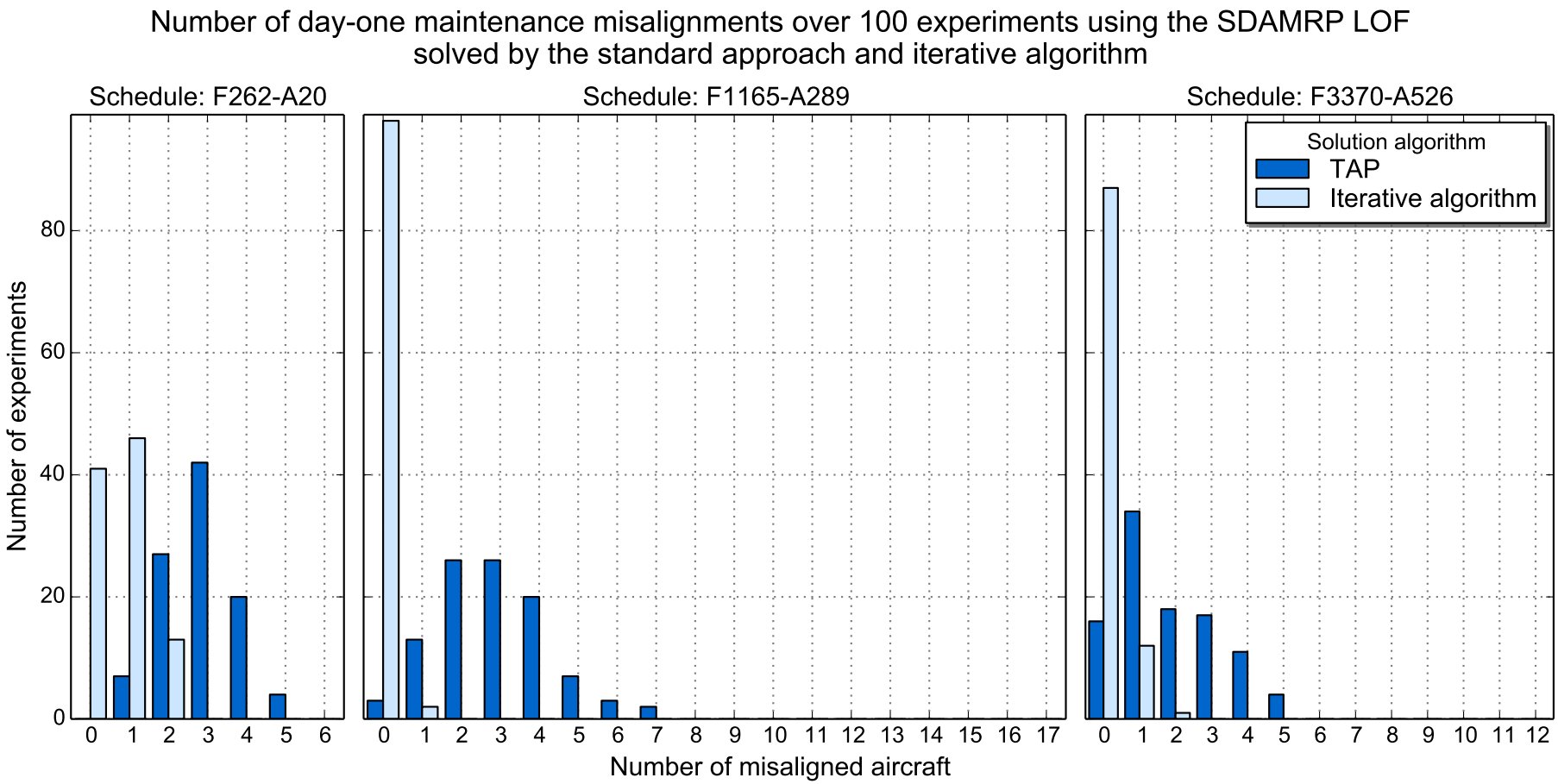
Day-one maintenance misalignments

Aircraft routing LOF



Day-one maintenance misalignments

SDAMRP LOF



Conclusions

- Developed a tail assignment problem for one-day lines-of-flight to satisfy maintenance requirements and perform necessary gate assignment changes.
- Evaluated the ability of fixed lines-of-flight to satisfy maintenance requirements.
- Developed an iterative algorithm to reduced maintenance misalignments.
- Demonstrated the efficacy of the iterative algorithm.