

Development and Validation of an Automated Simulation Capability in Support of Integrated Demand Management

Heather Arneson

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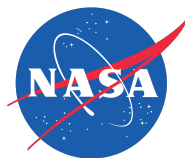
Crown Consulting Inc., NASA Ames Research Center

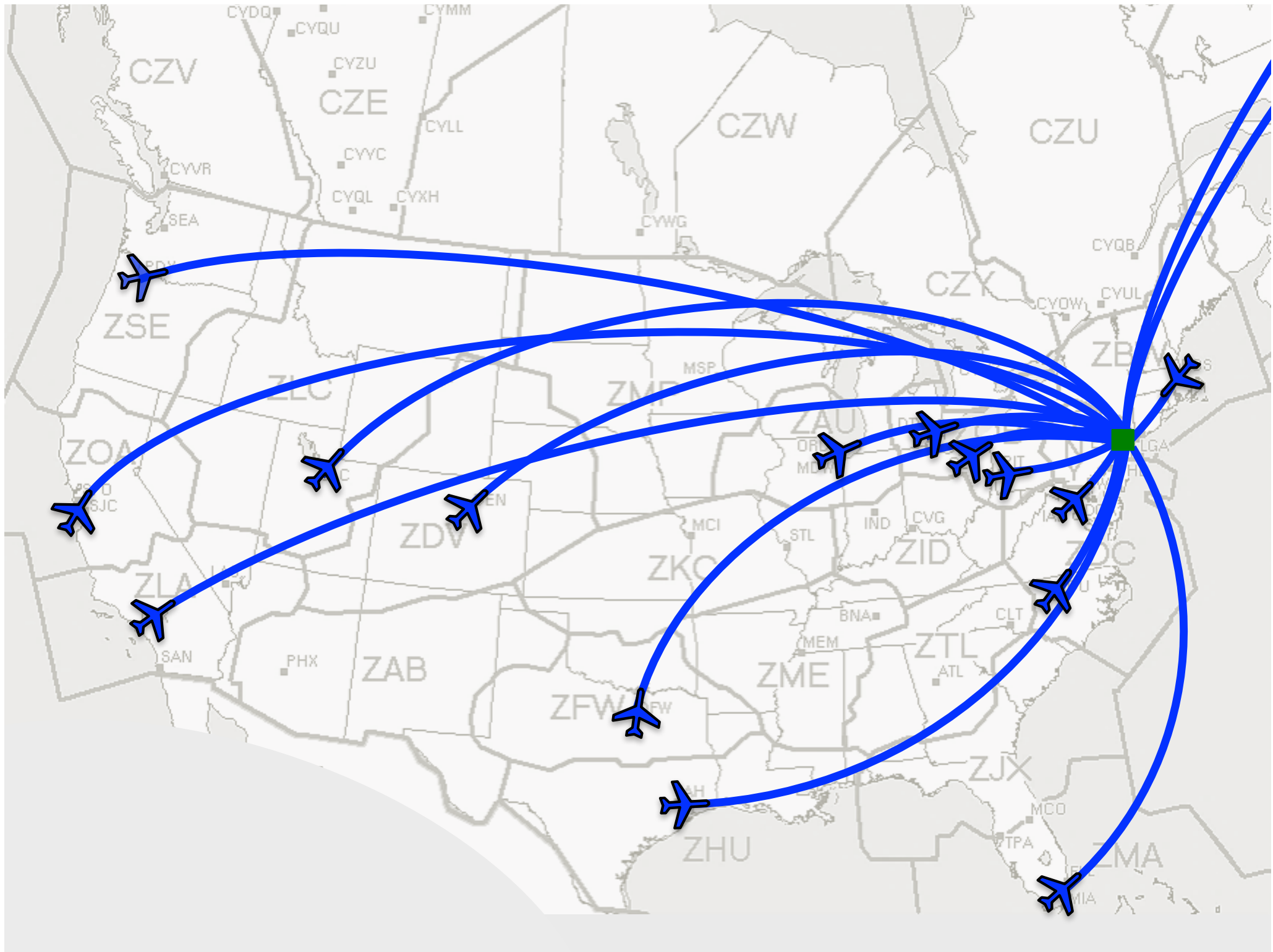
Jinhua Li

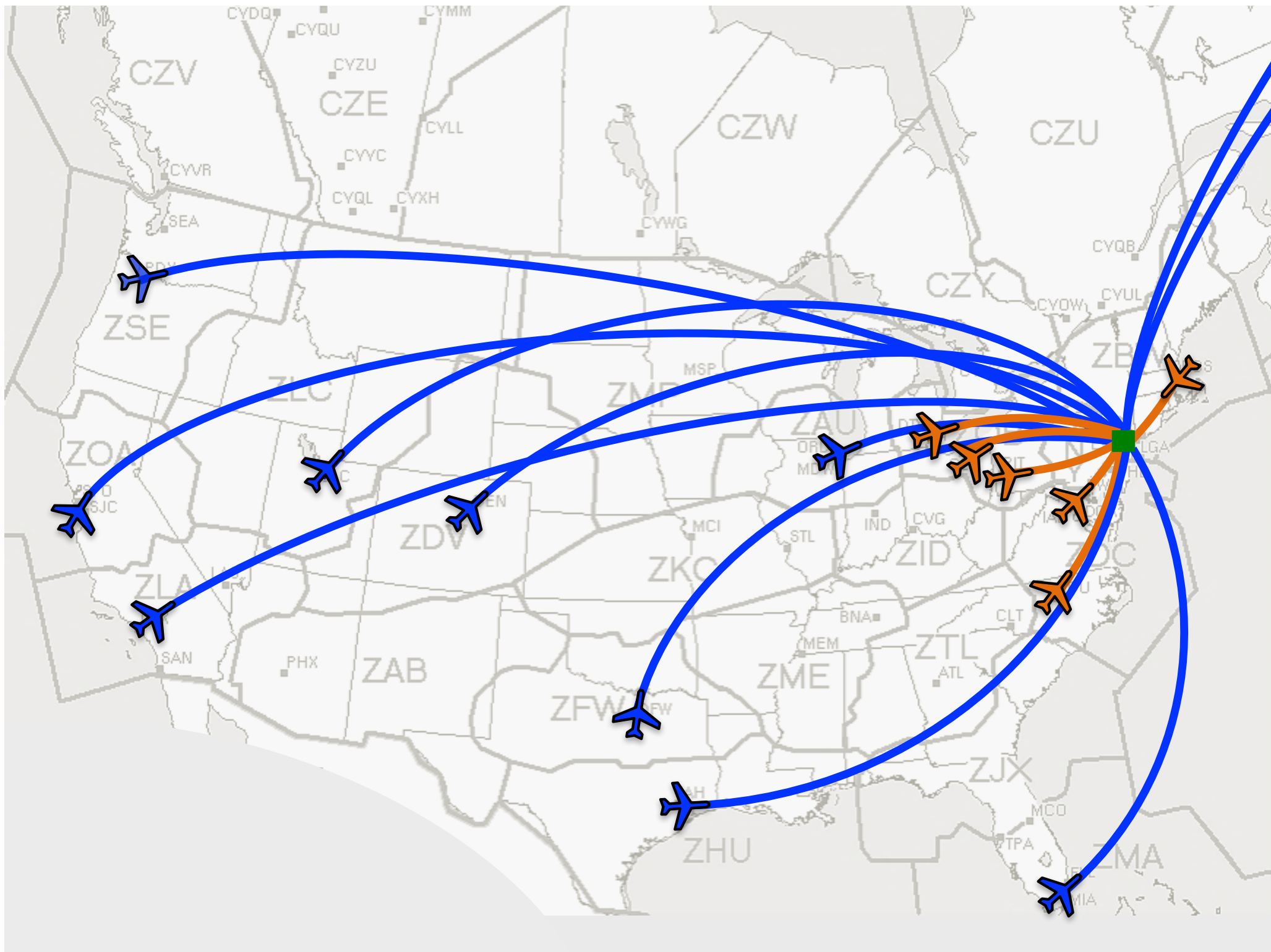
Universities Space Research Association, NASA Ames Research Center

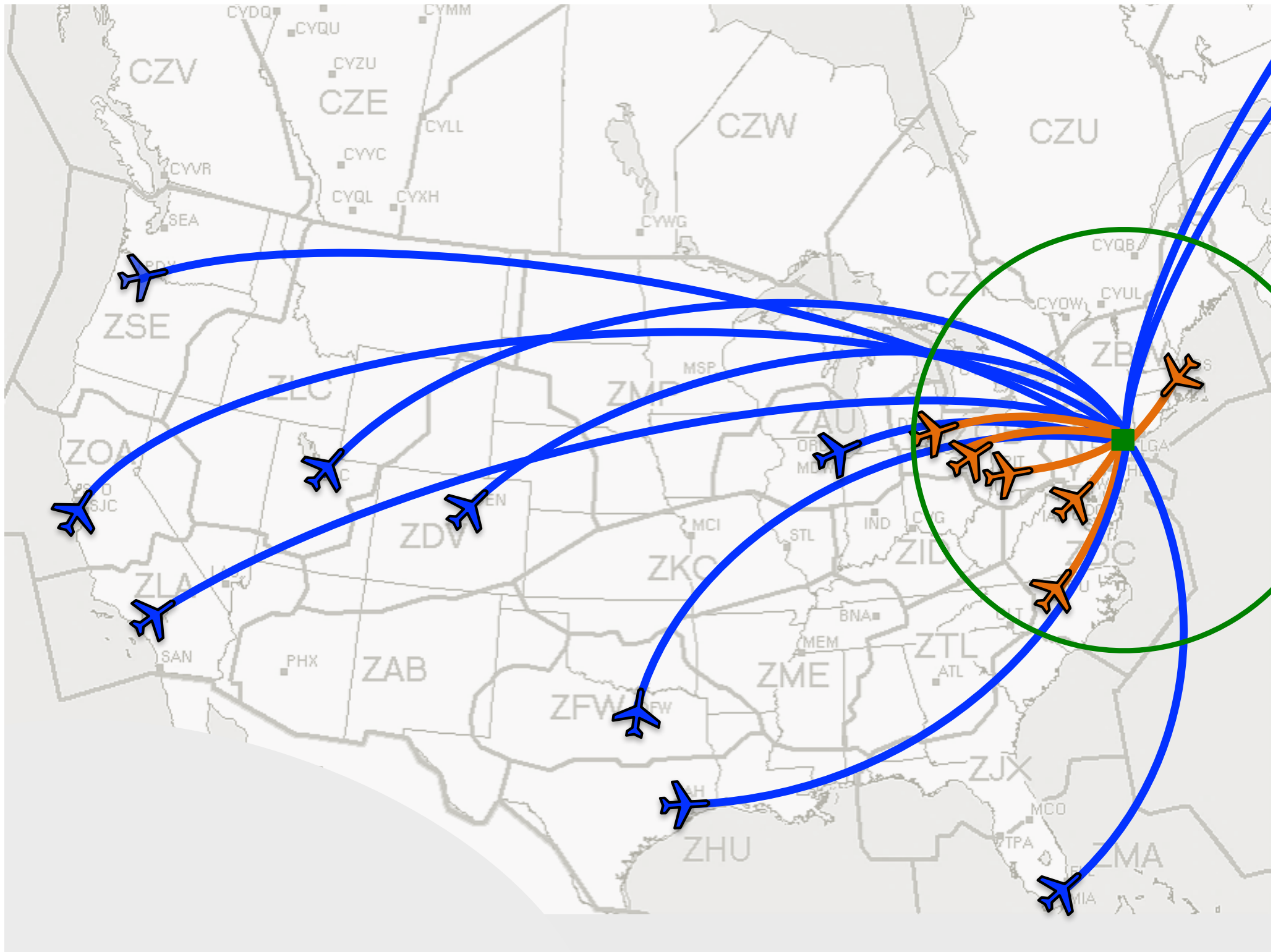
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Strategic Planning

Tactical Planning

Human-in-the-loop (HITL) simulations

- Study integration of strategic and tactical planning tools
 - Strategic:
 - Pre-departure ground delay
 - ⇒ Adjusts demand to roughly meet airport arrival constraint
 - Tactical:
 - Airborne delay near arrival airport
 - Pre-departure ground delay for short-haul flights
 - ⇒ Delivers demand to actual arrival rate constraint
- Subject matter expert participants:
 - Air traffic controllers
 - Traffic flow managers

Challenges of HITL simulations

- **Expensive**
 - Subject matter expert participants
 - Simulation support staff
- **Time consuming**

Minimum of 5 hours to capture long-haul flights pre-departure
- **Limitations**
 - Number of simulations executed
 - Number of airspace sectors that can be populated with traffic
 - Traffic volume

Motivation

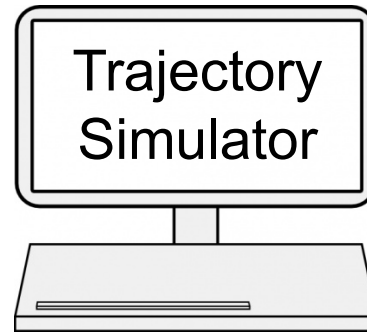
- Evaluate over larger variation in parameters
- Simulate larger, more realistic traffic scenarios
- Augment HITL with automated background traffic

Objectives

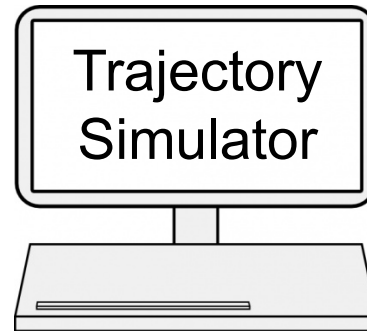
- Automate HITL simulation
- Emulate HITL simulation results
- Maintain high fidelity trajectory simulation
- Incorporate updates to strategic planning tool

- Simulation structure
 - HITL simulation
 - HITL participant actions
 - Automated simulation capability
- Initial validation
- Conclusions and future work

Simulation structure



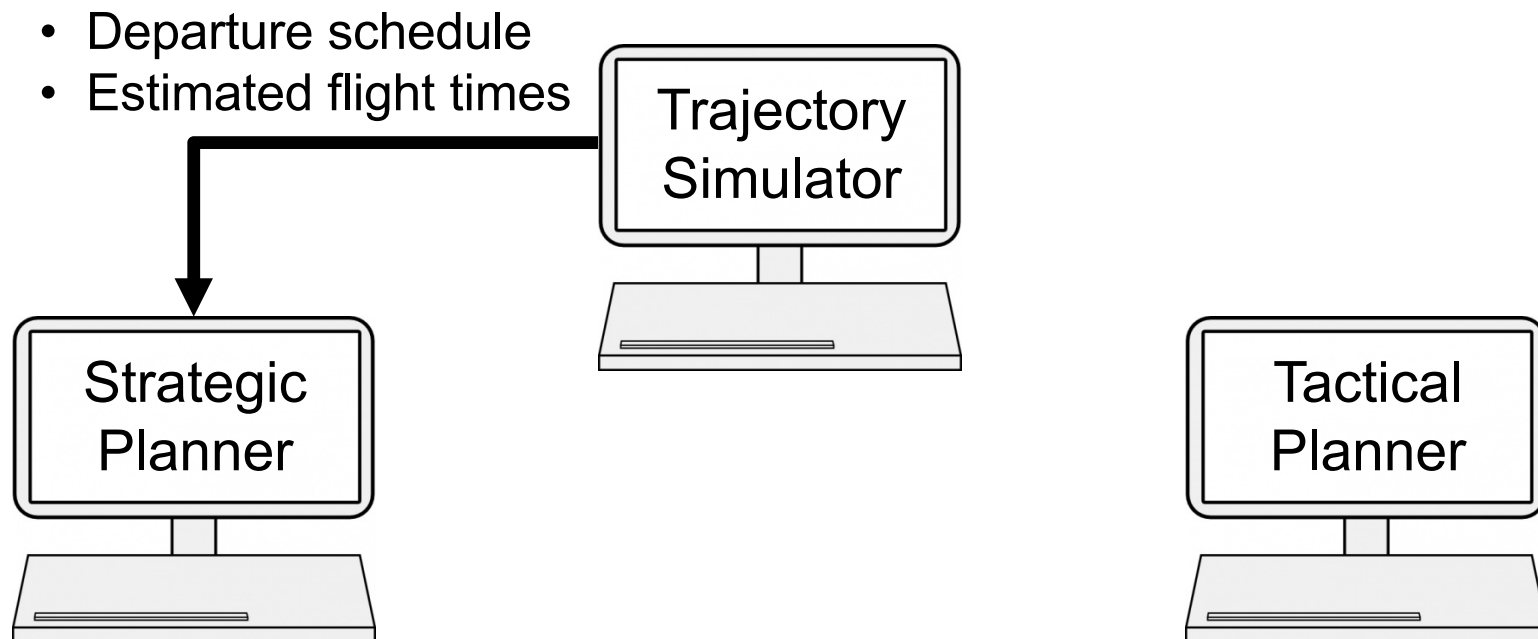
Simulation structure



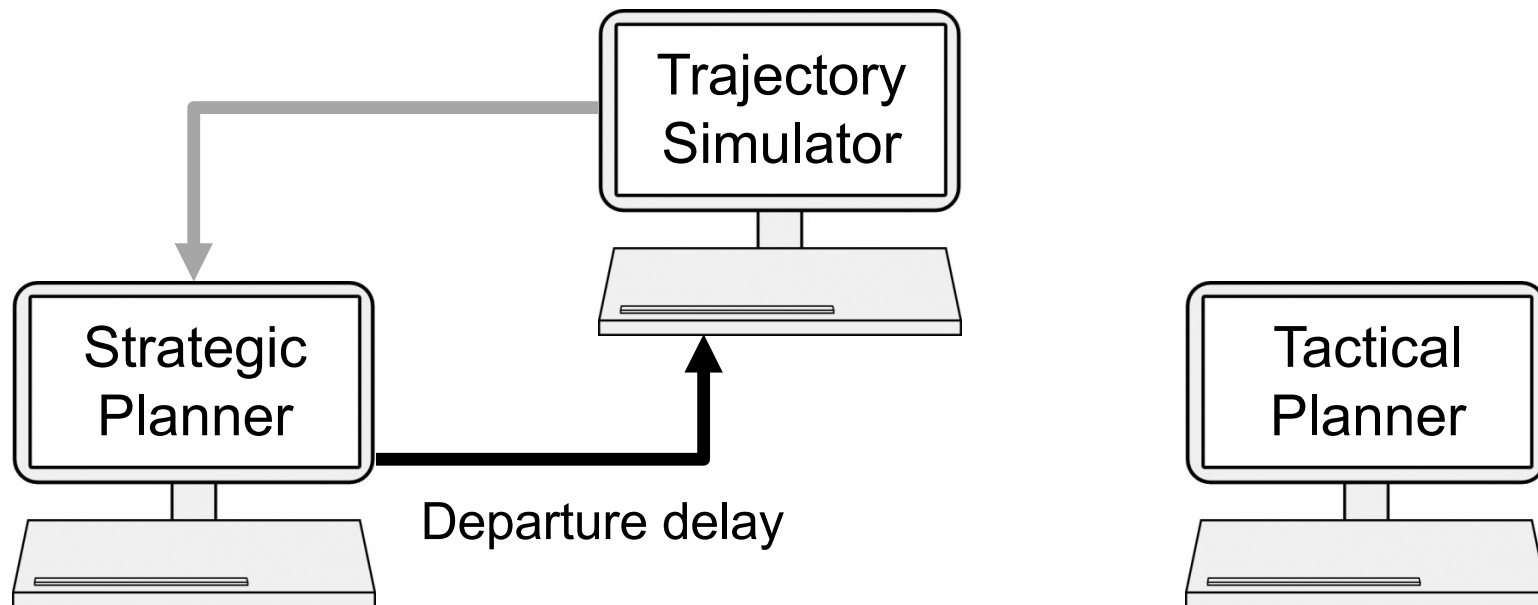
Simulation structure



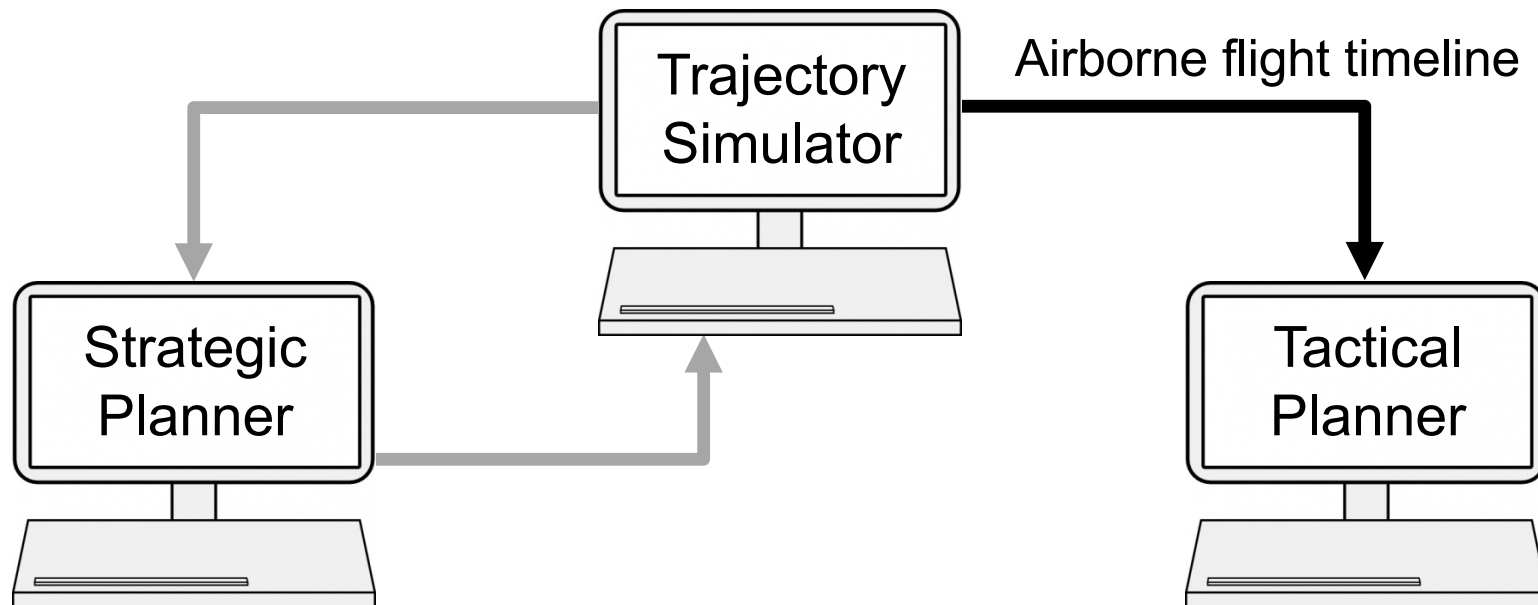
Simulation structure



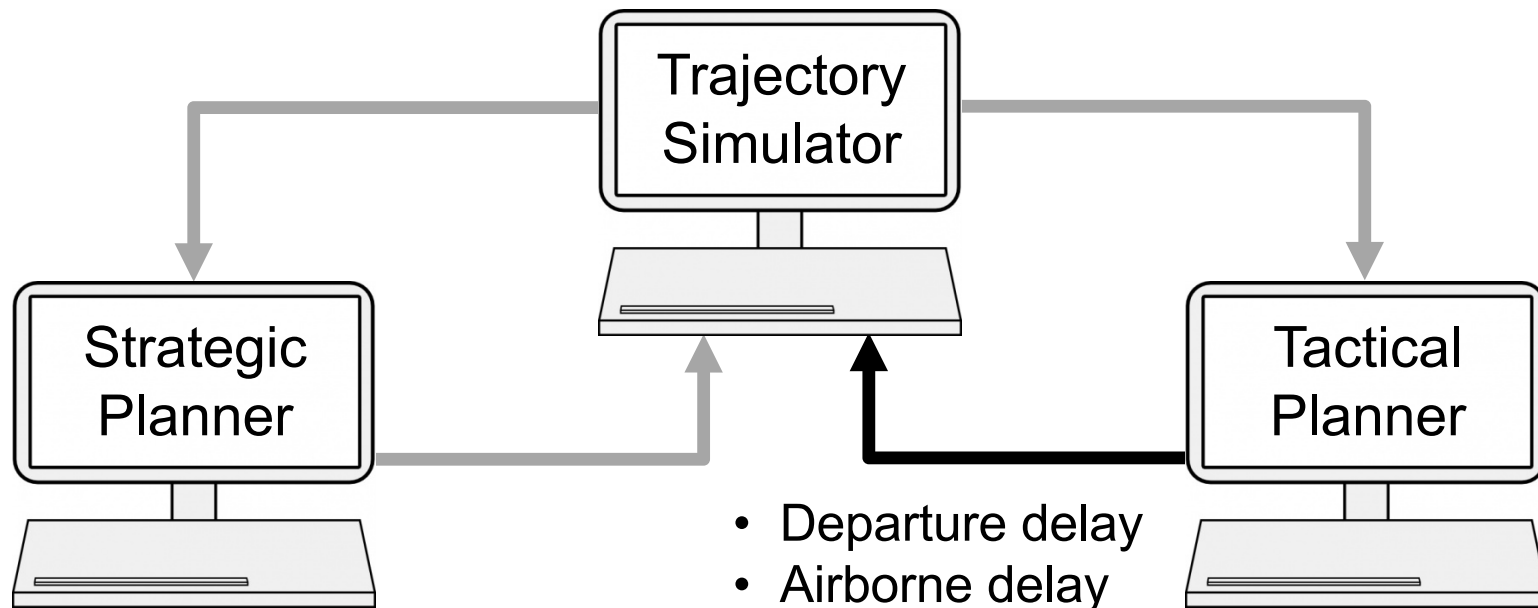
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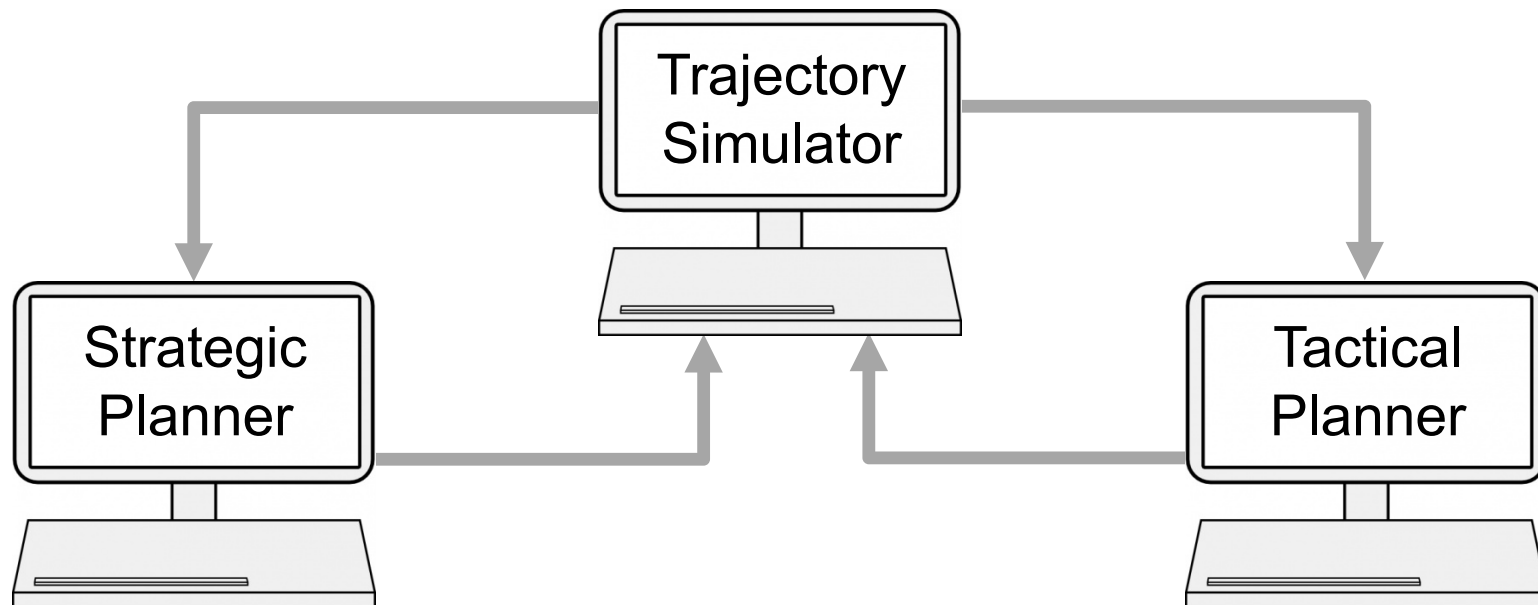
Simulation structure



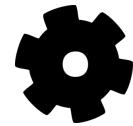
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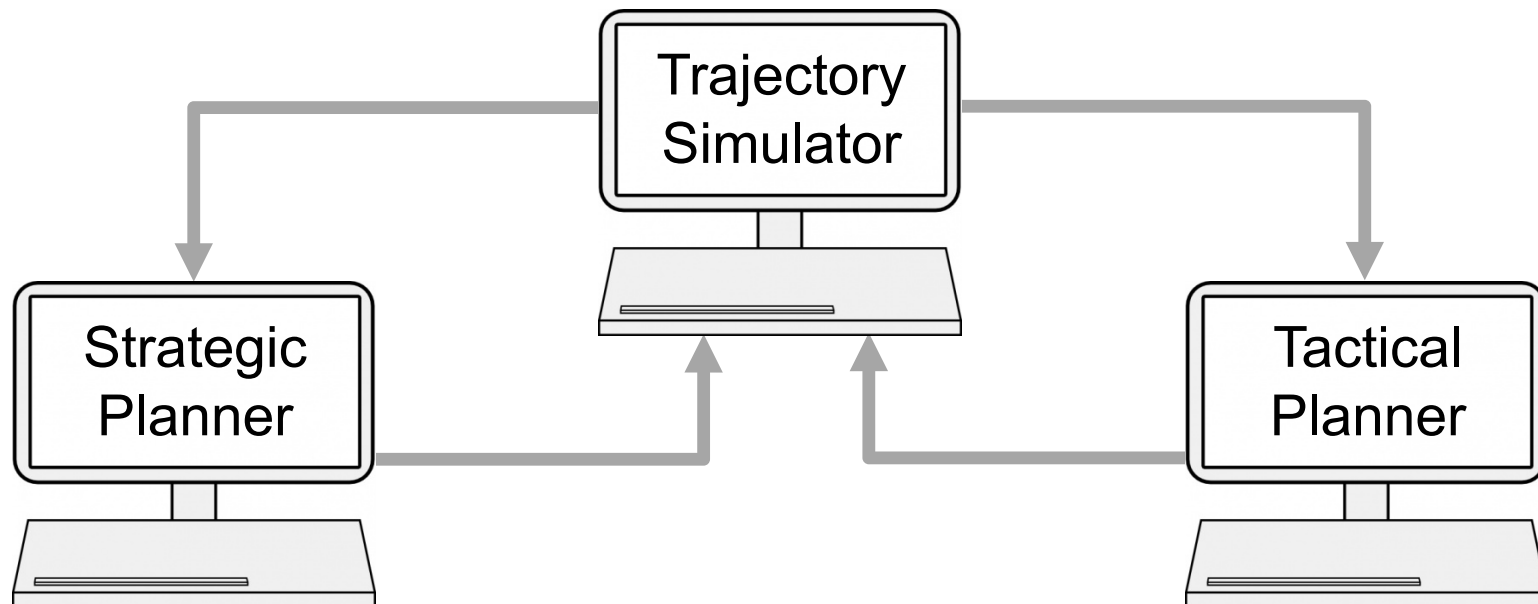
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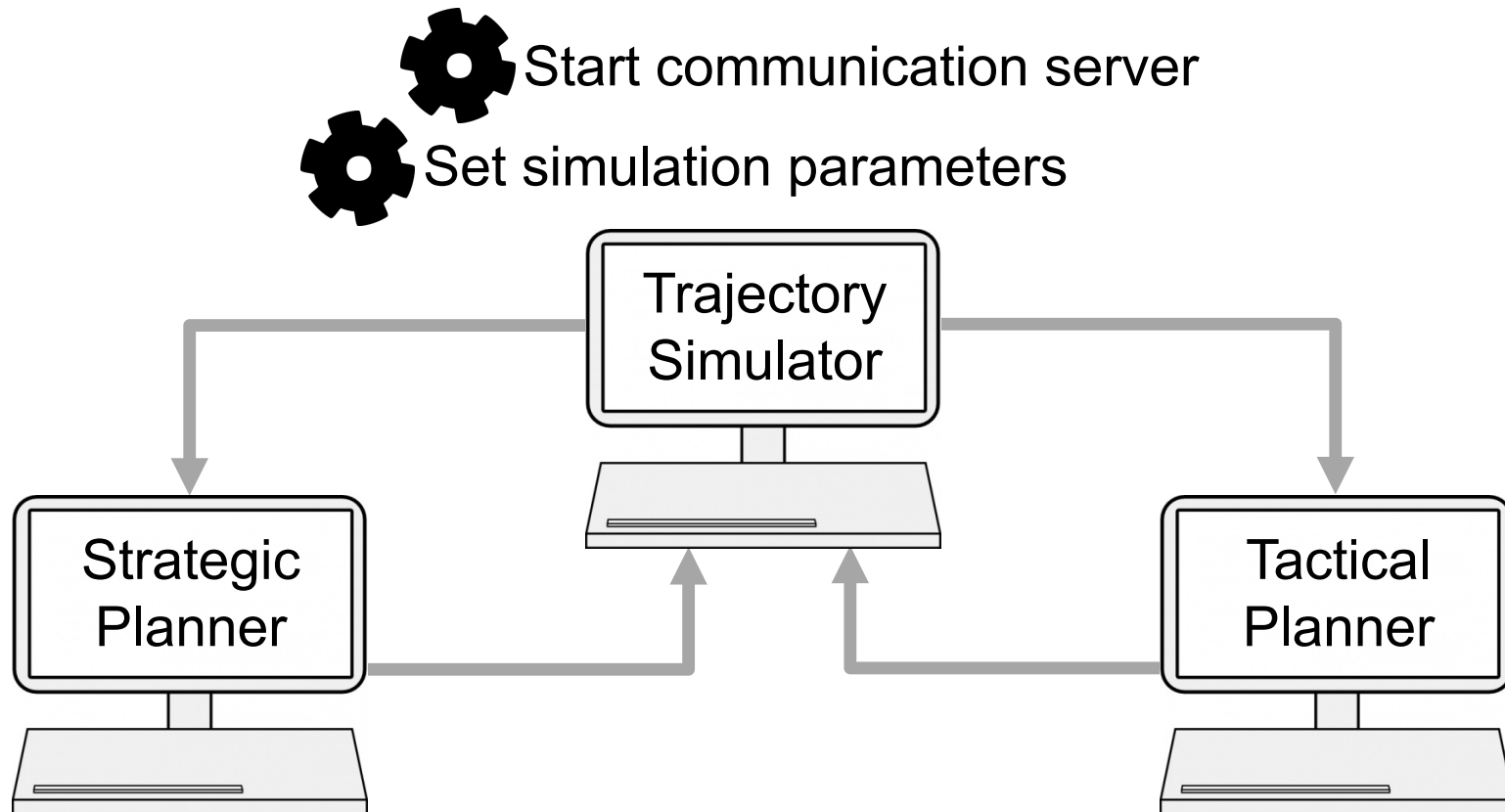
Simulation structure



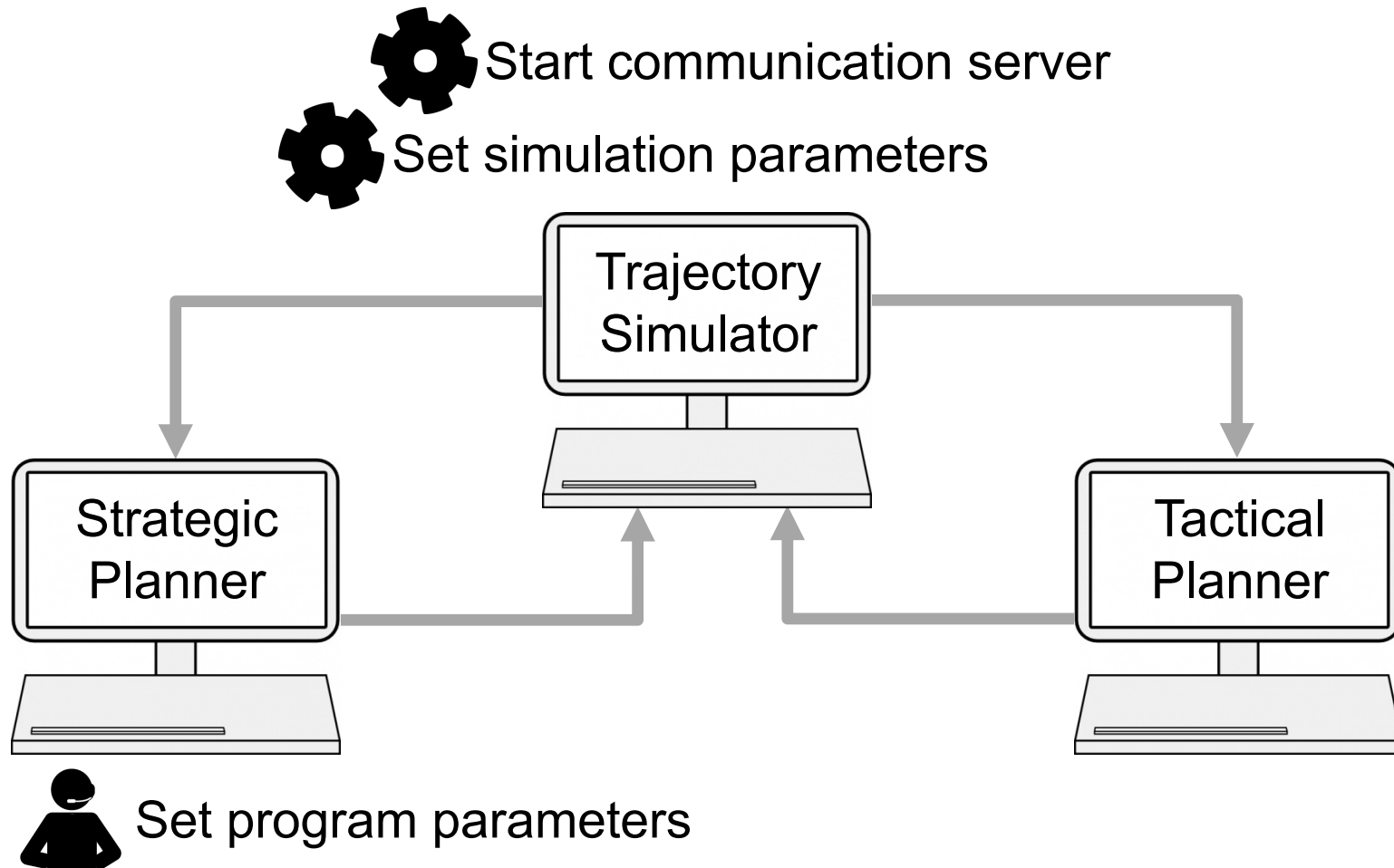
Start communication server



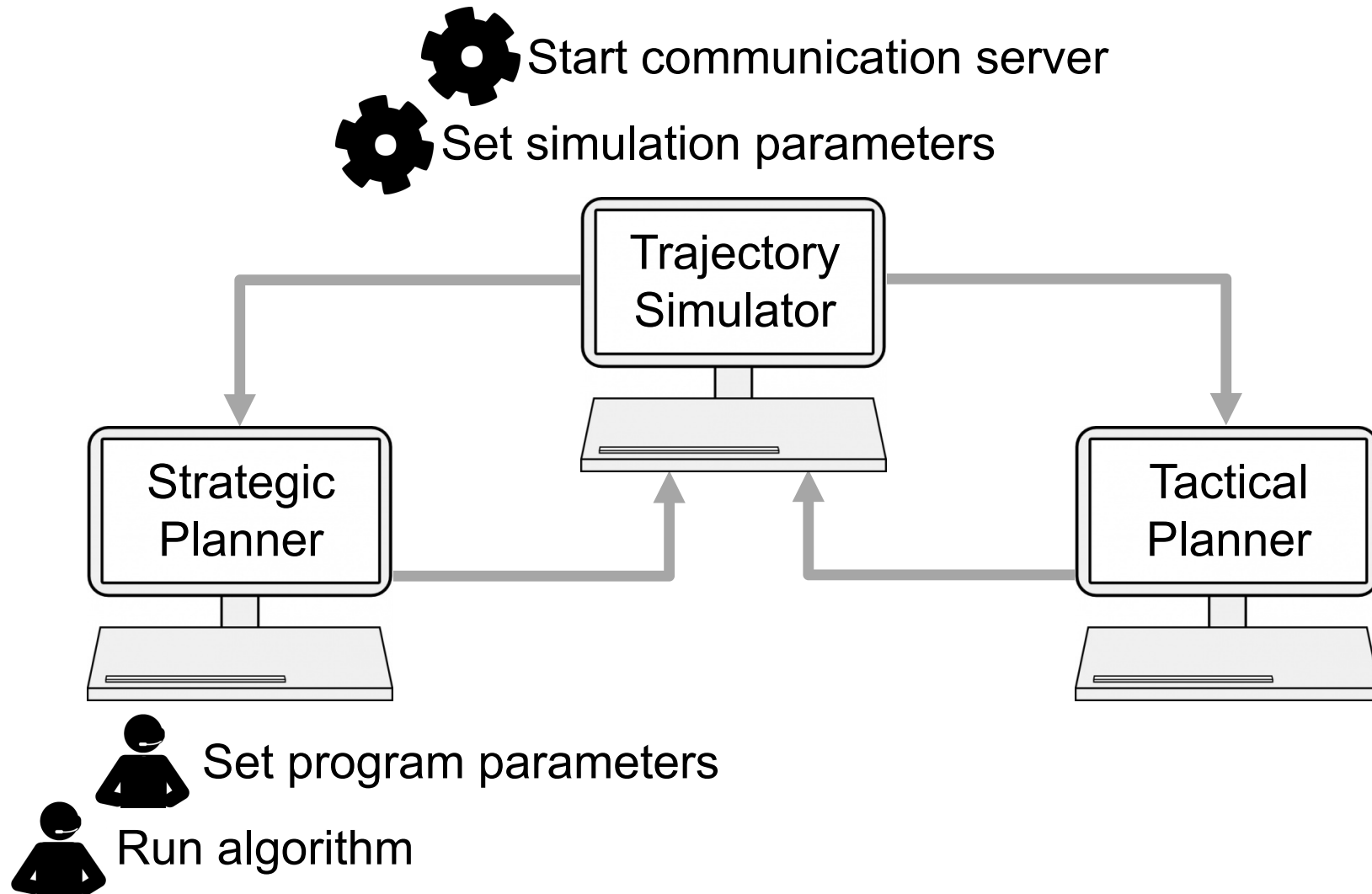
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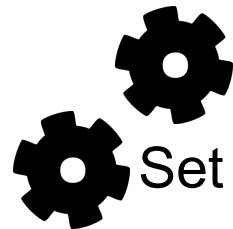
Simulation structure

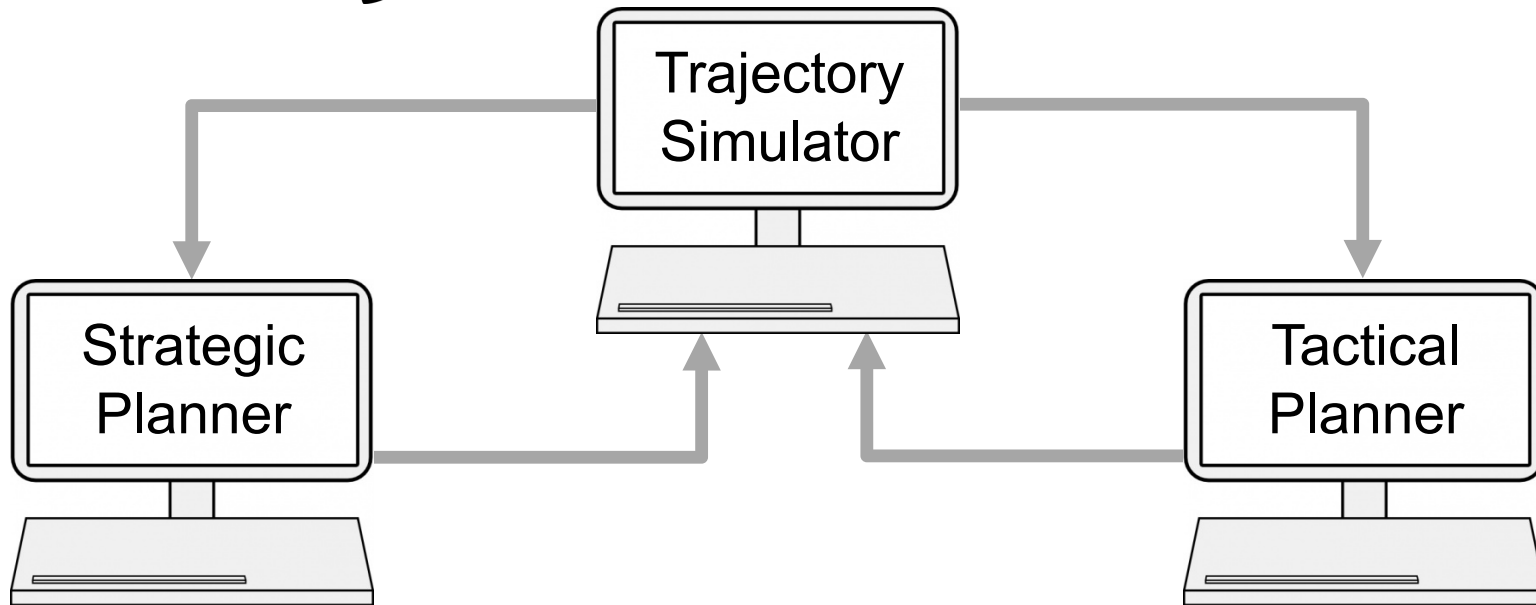





Simulation structure



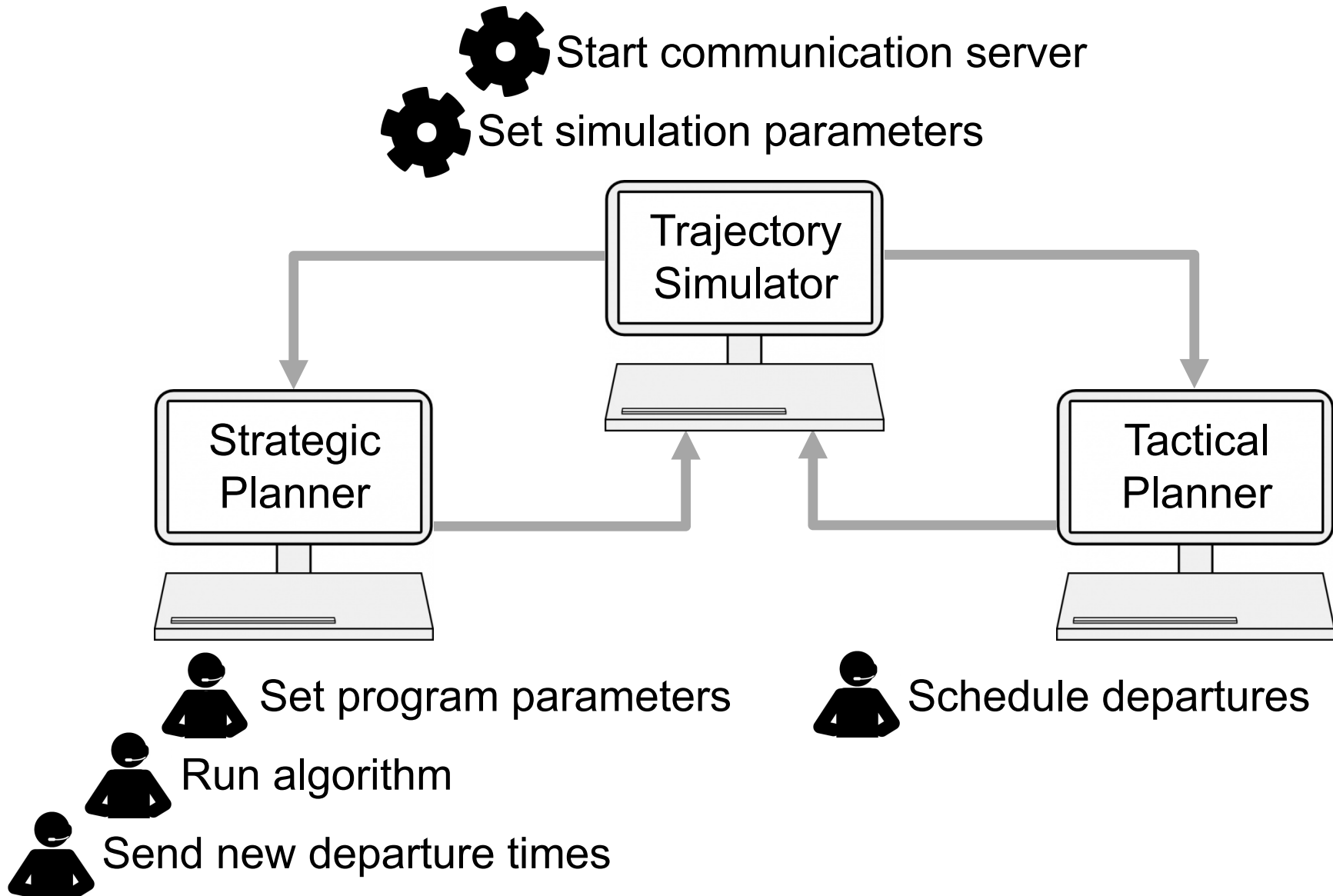
Simulation structure

 Start communication server
Set simulation parameters

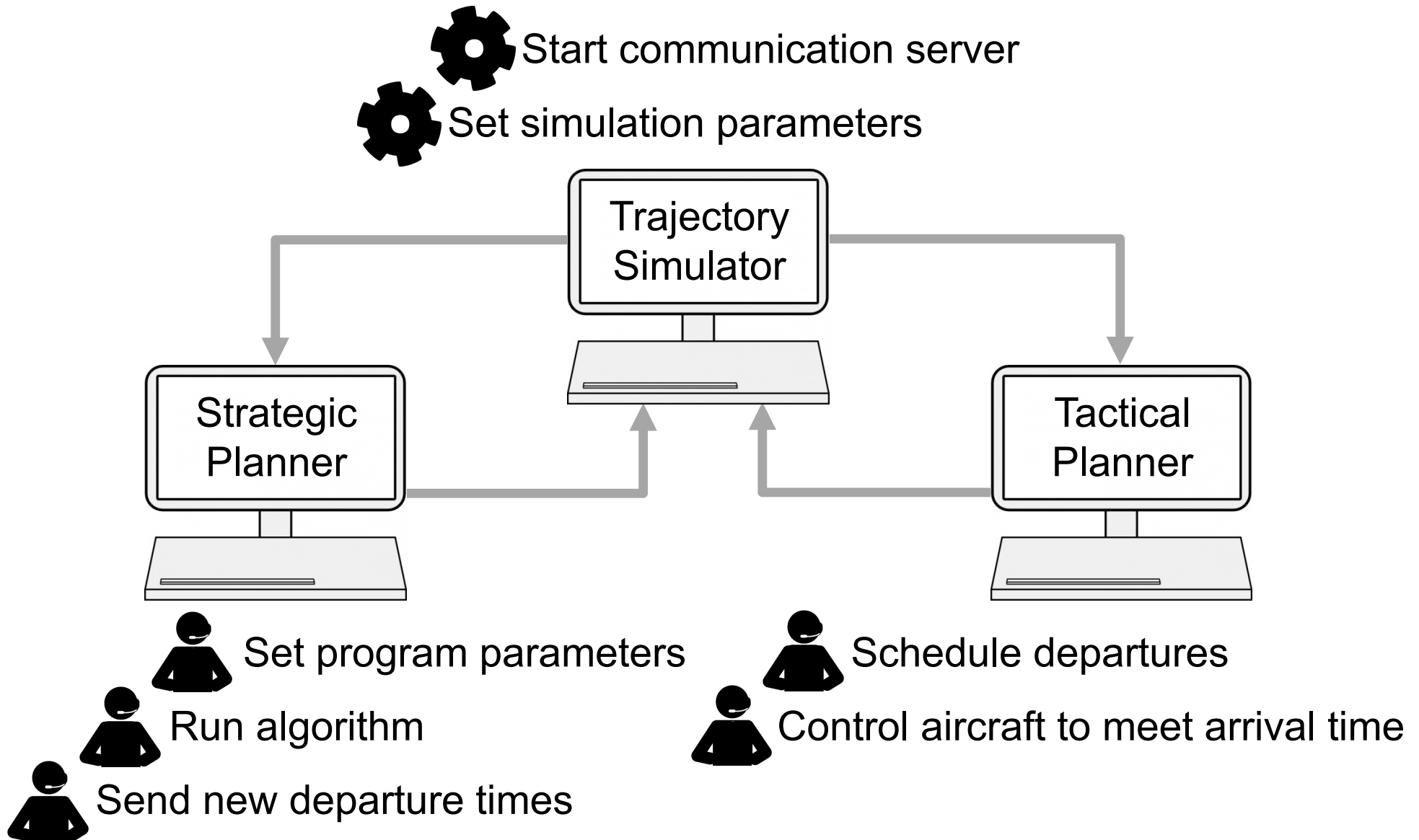


 Set program parameters
 Run algorithm
 Send new departure times



Simulation structure

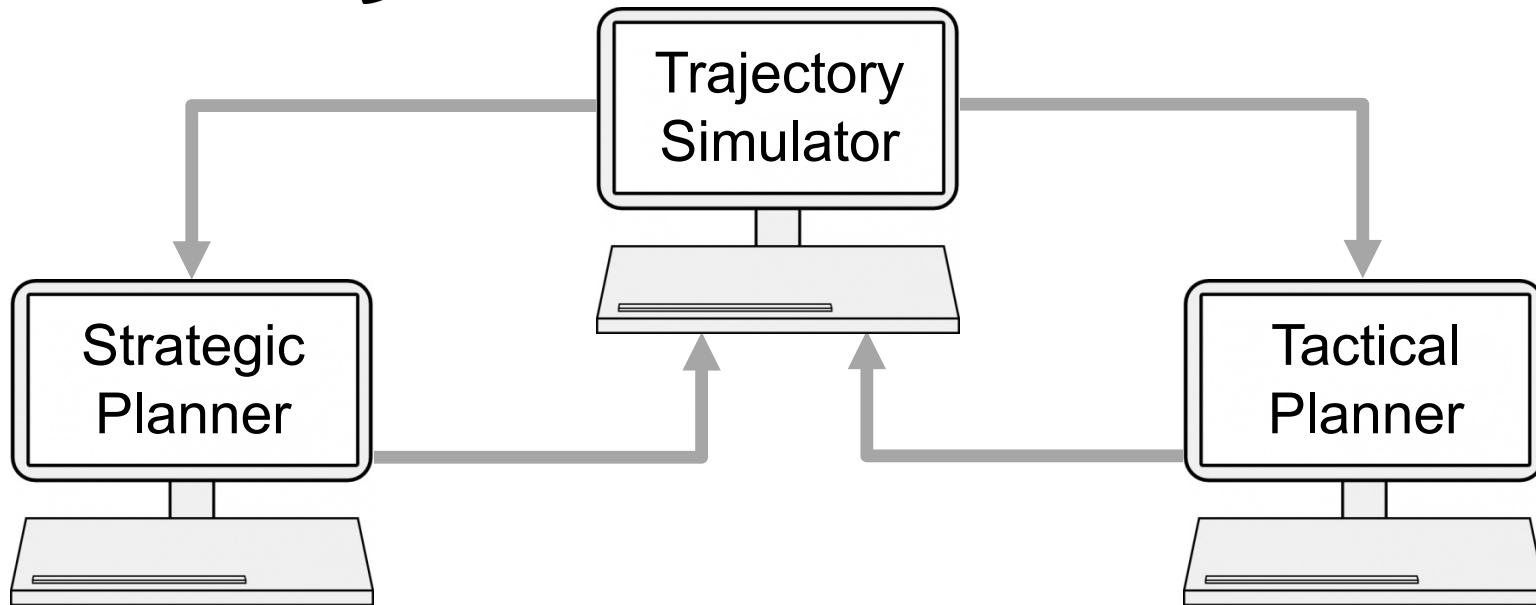







Simulation structure



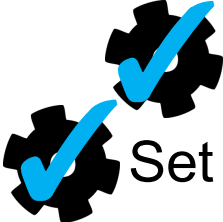

Simulation structure

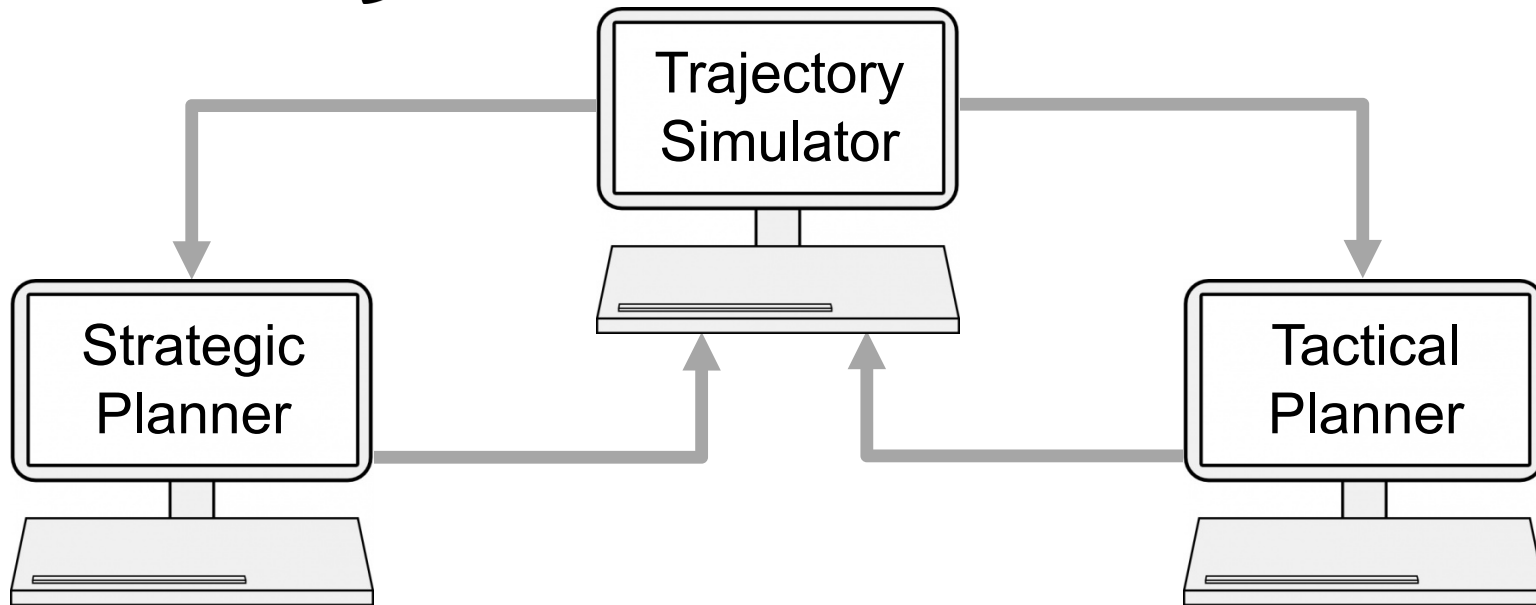
-  Start communication server
-  Set simulation parameters








-  Set program parameters
-  Run algorithm
-  Send new departure times
-  Schedule departures
-  Control aircraft to meet arrival time

Simulation structure

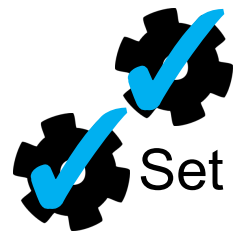
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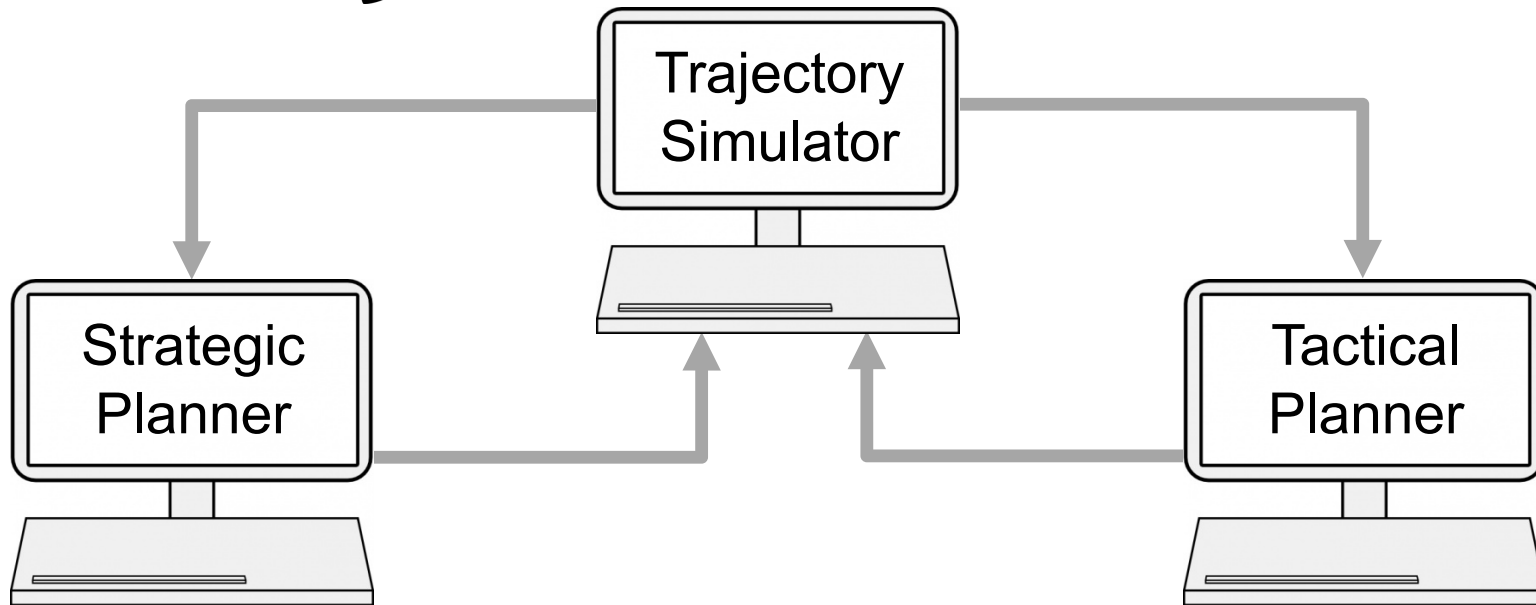





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Simulation structure

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Set simulation parameters

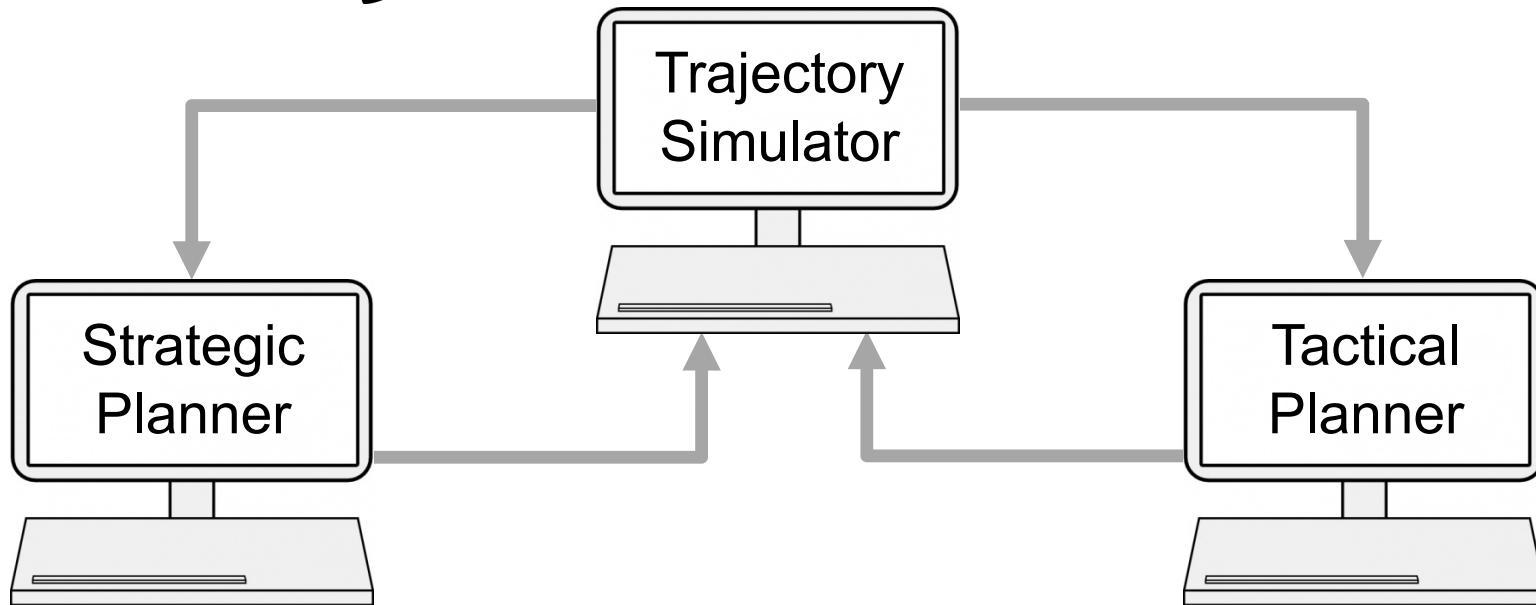


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Simulation structure

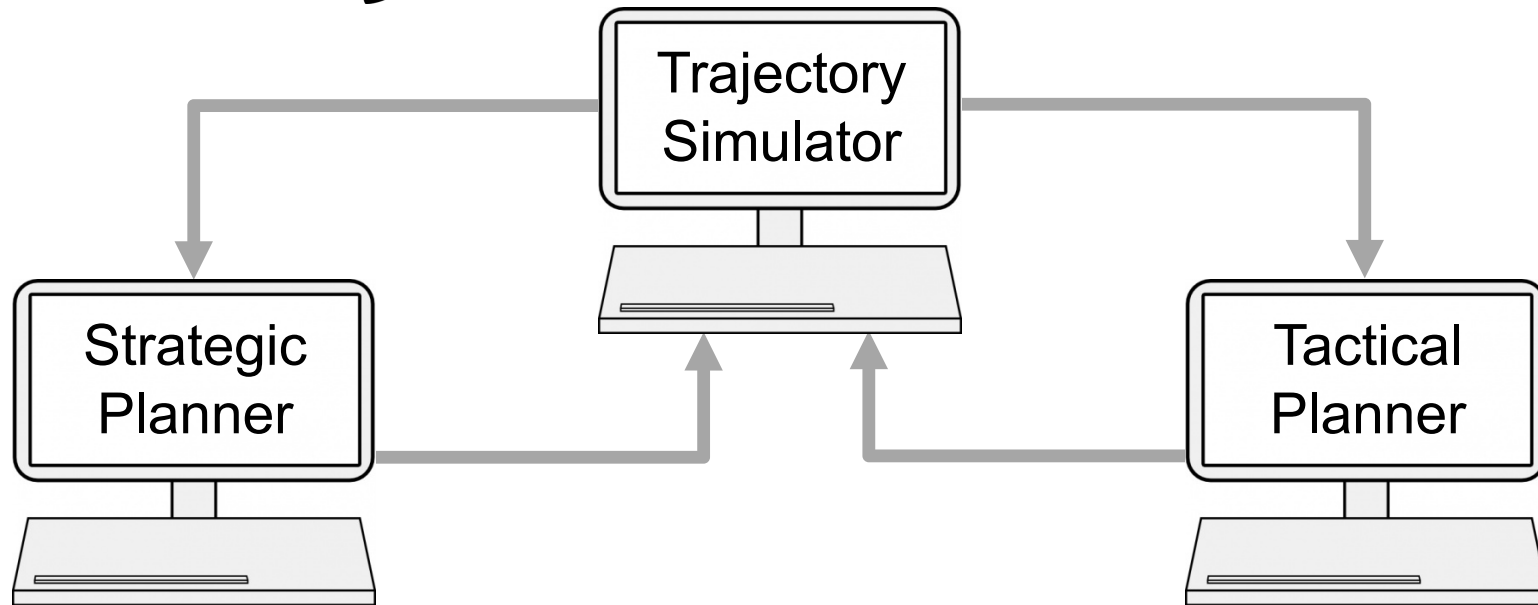
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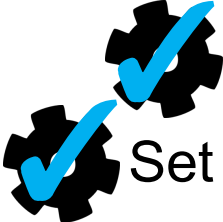

Simulation structure

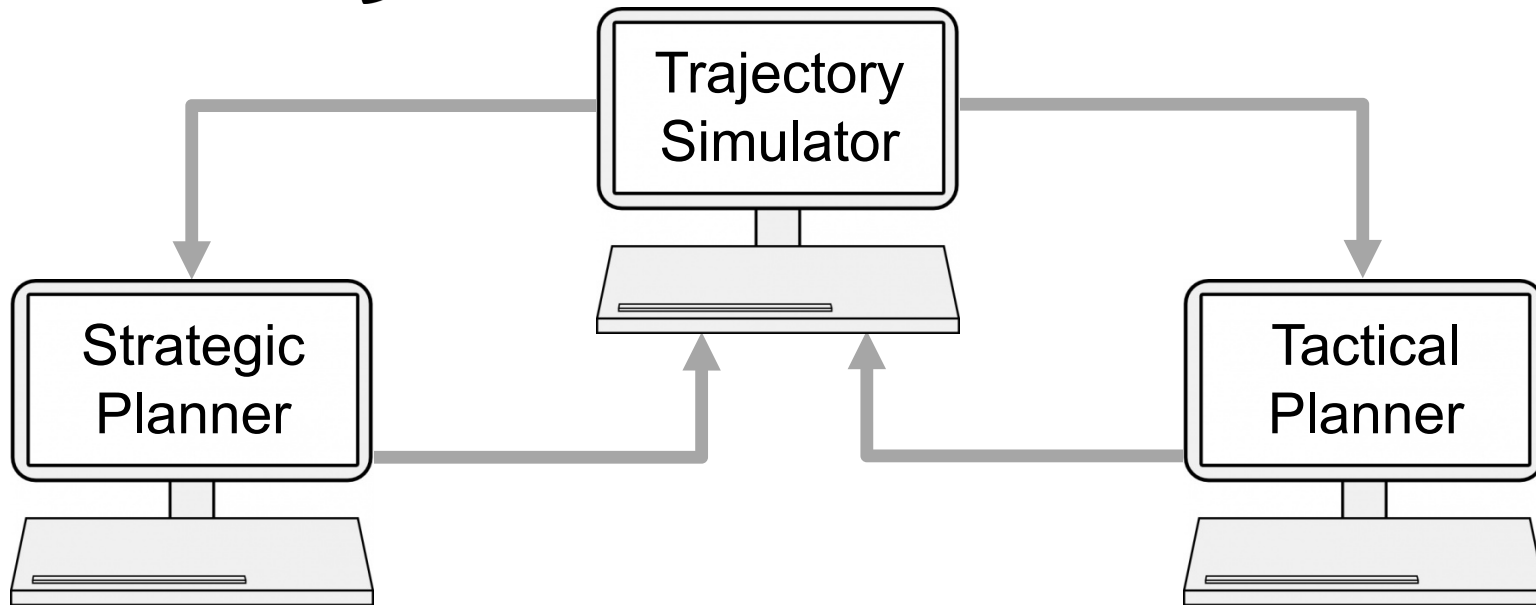
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Simulation structure

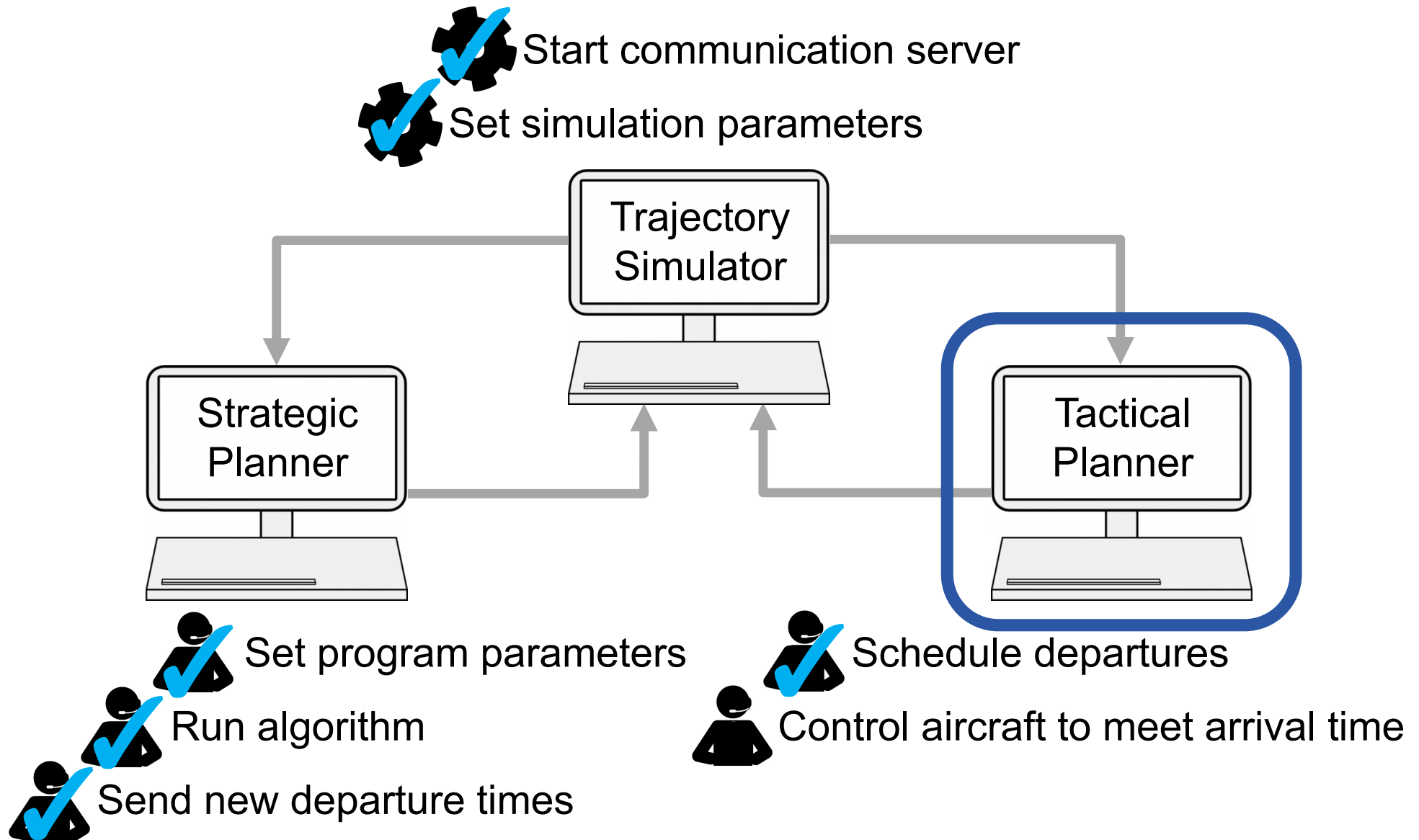
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-  Set simulation parameters



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-  Run algorithm
-  Send new departure times

-  Schedule departures
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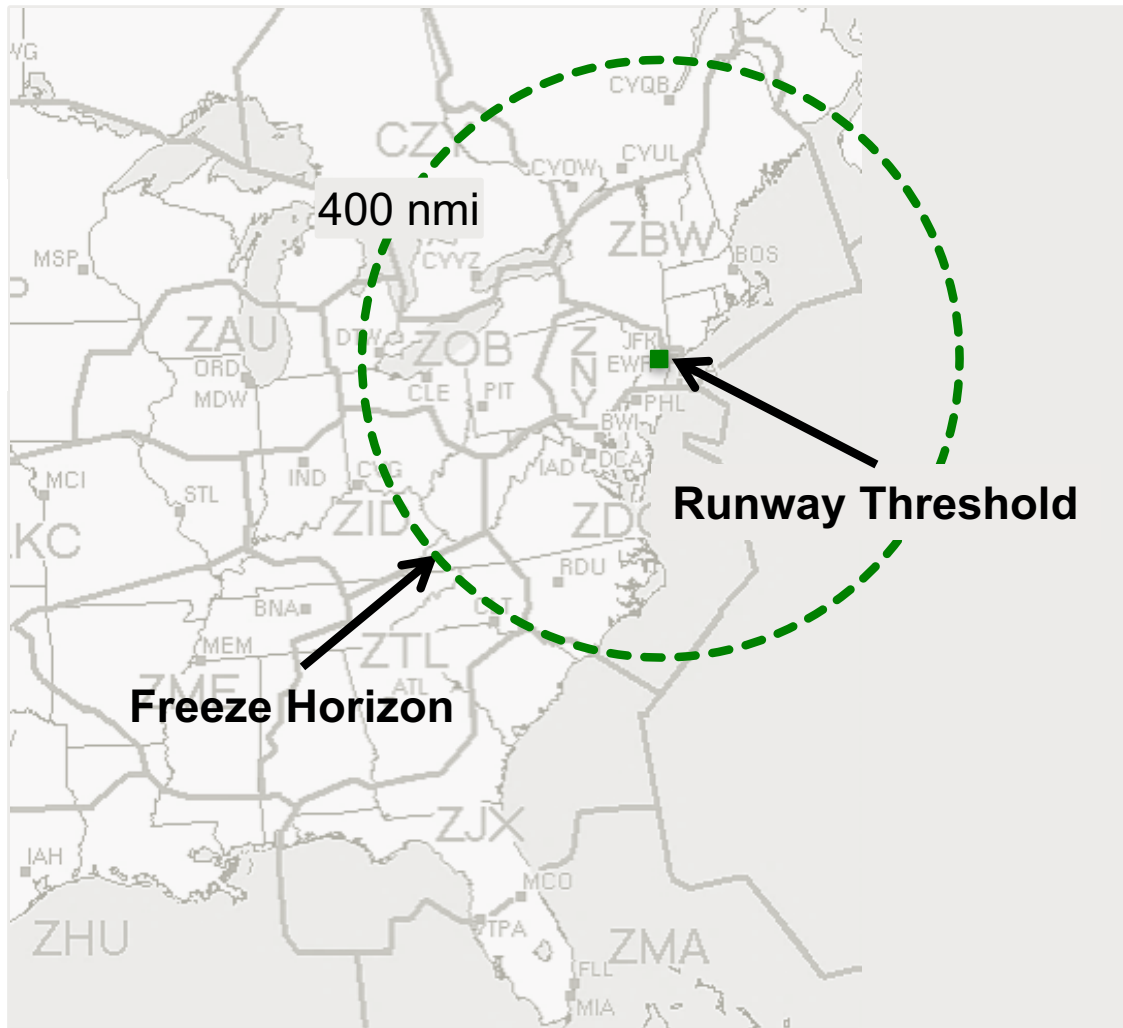
Simulation structure



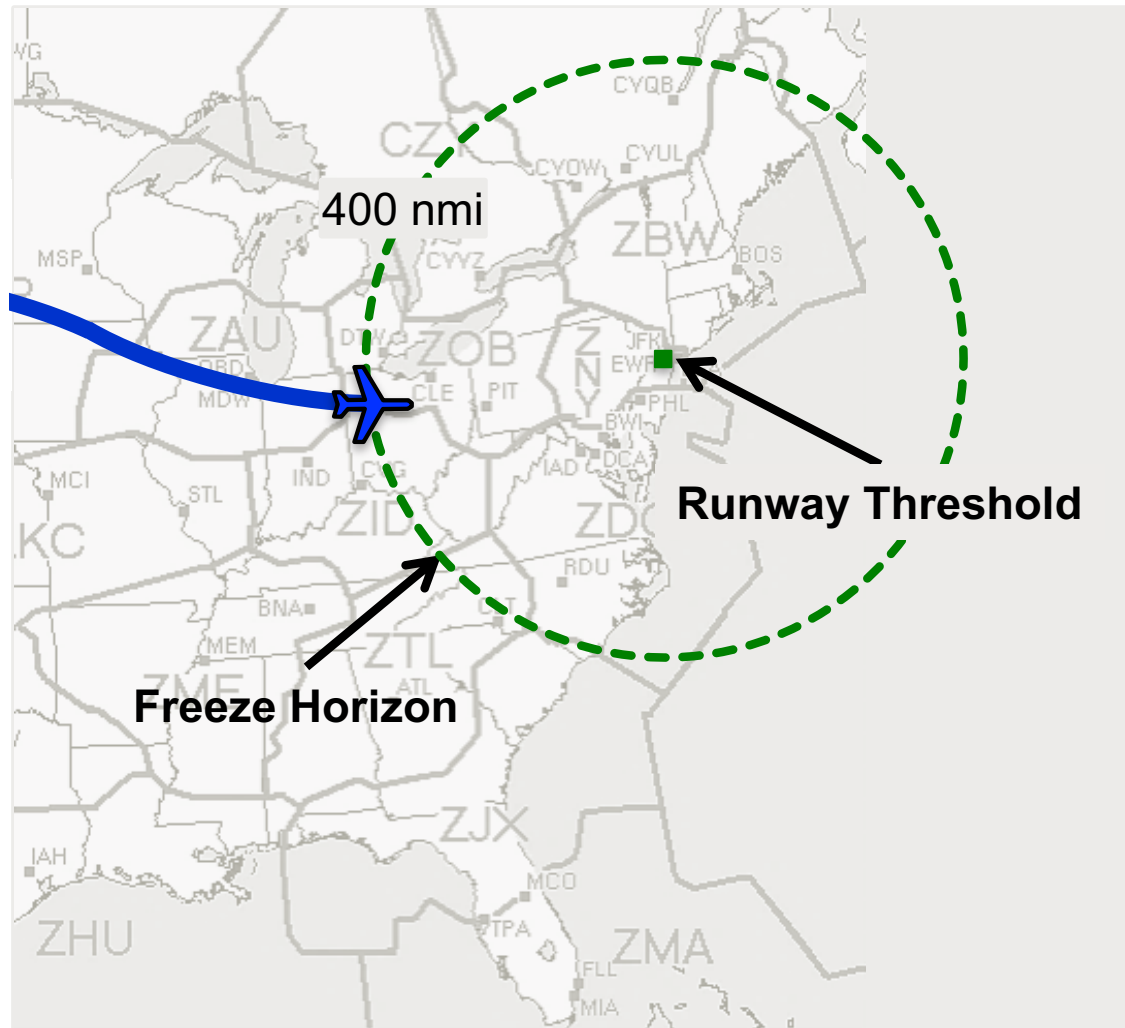
Tactical planner emulator

- Scheduler developed in house at NASA
 - Can run in fast-time
 - Code easily accessible for modification
- Adapted for Newark Liberty International Airport
- Modified to schedule internal departures automatically

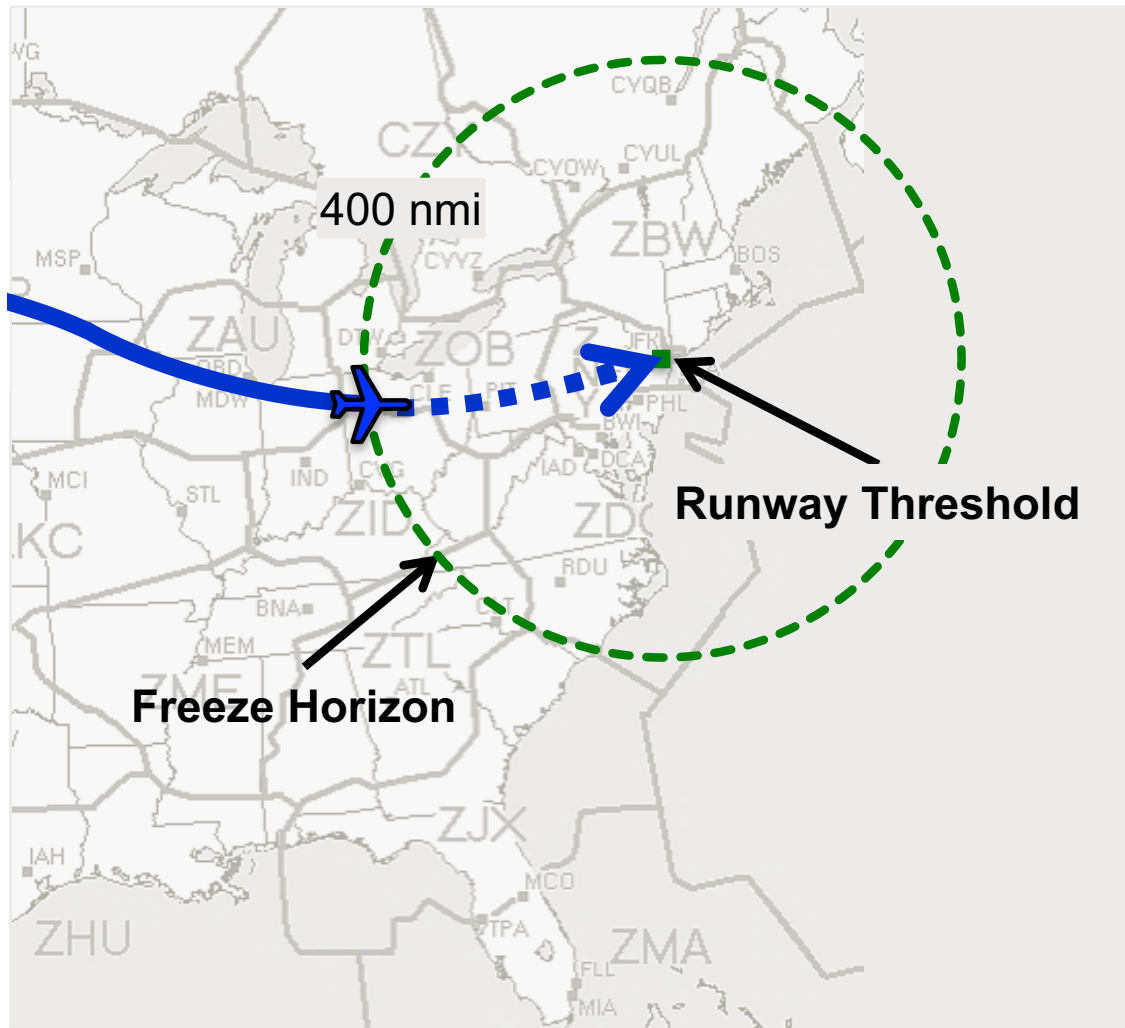
Tactical planning



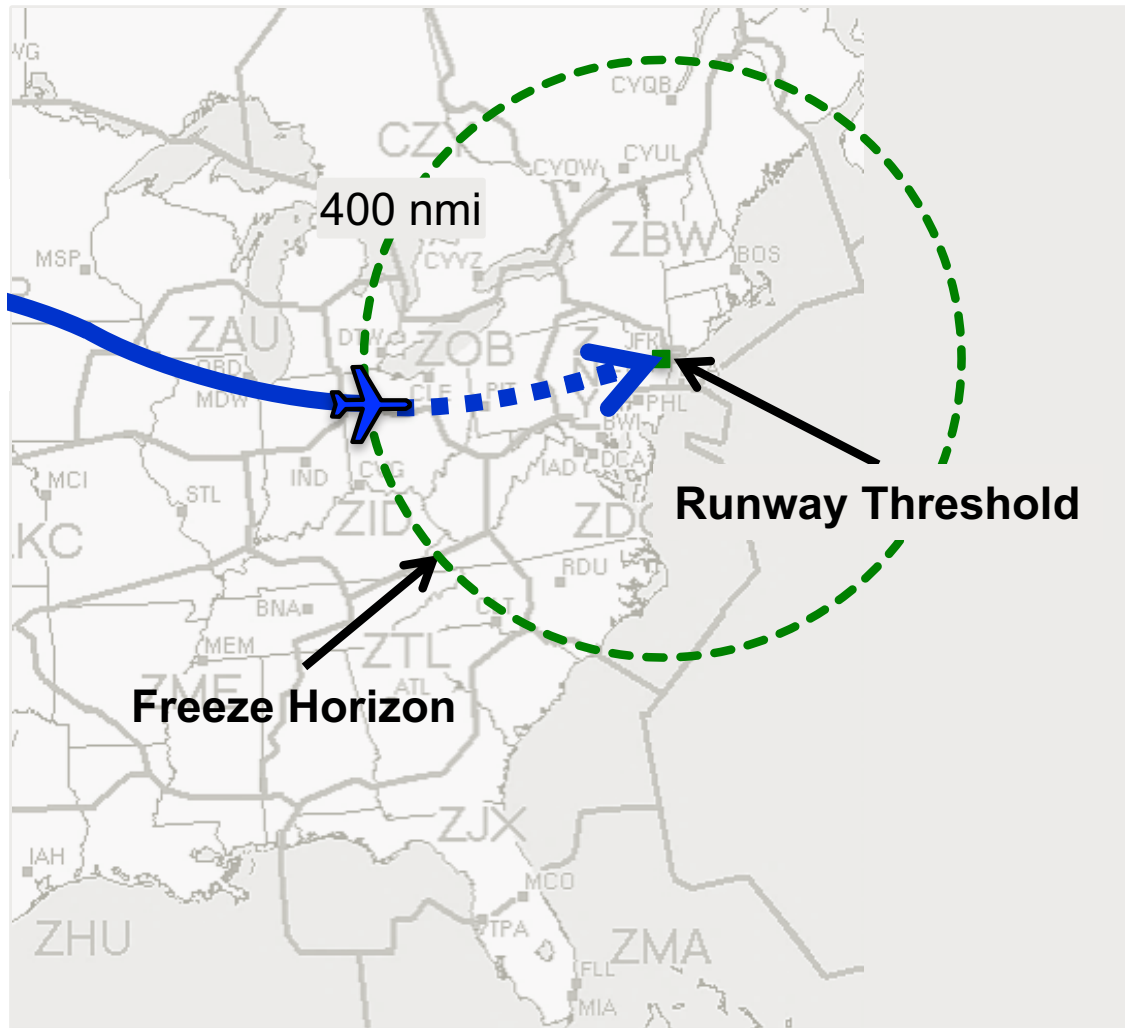
Tactical planning



Tactical planning

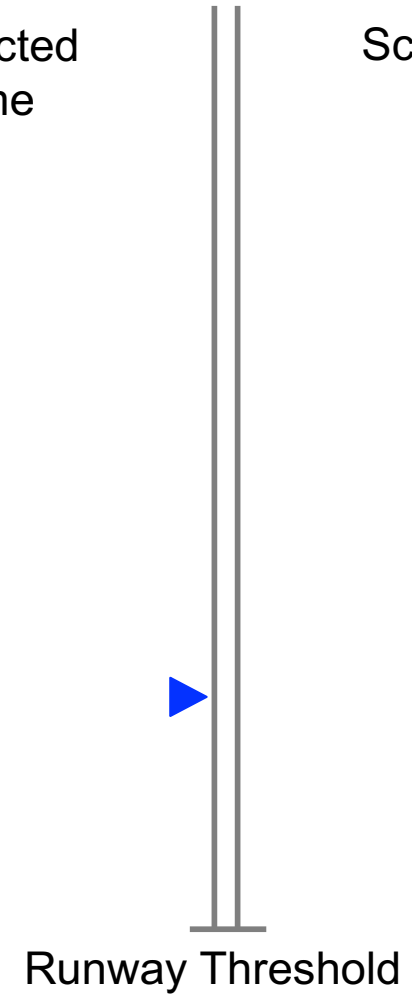


Tactical planning

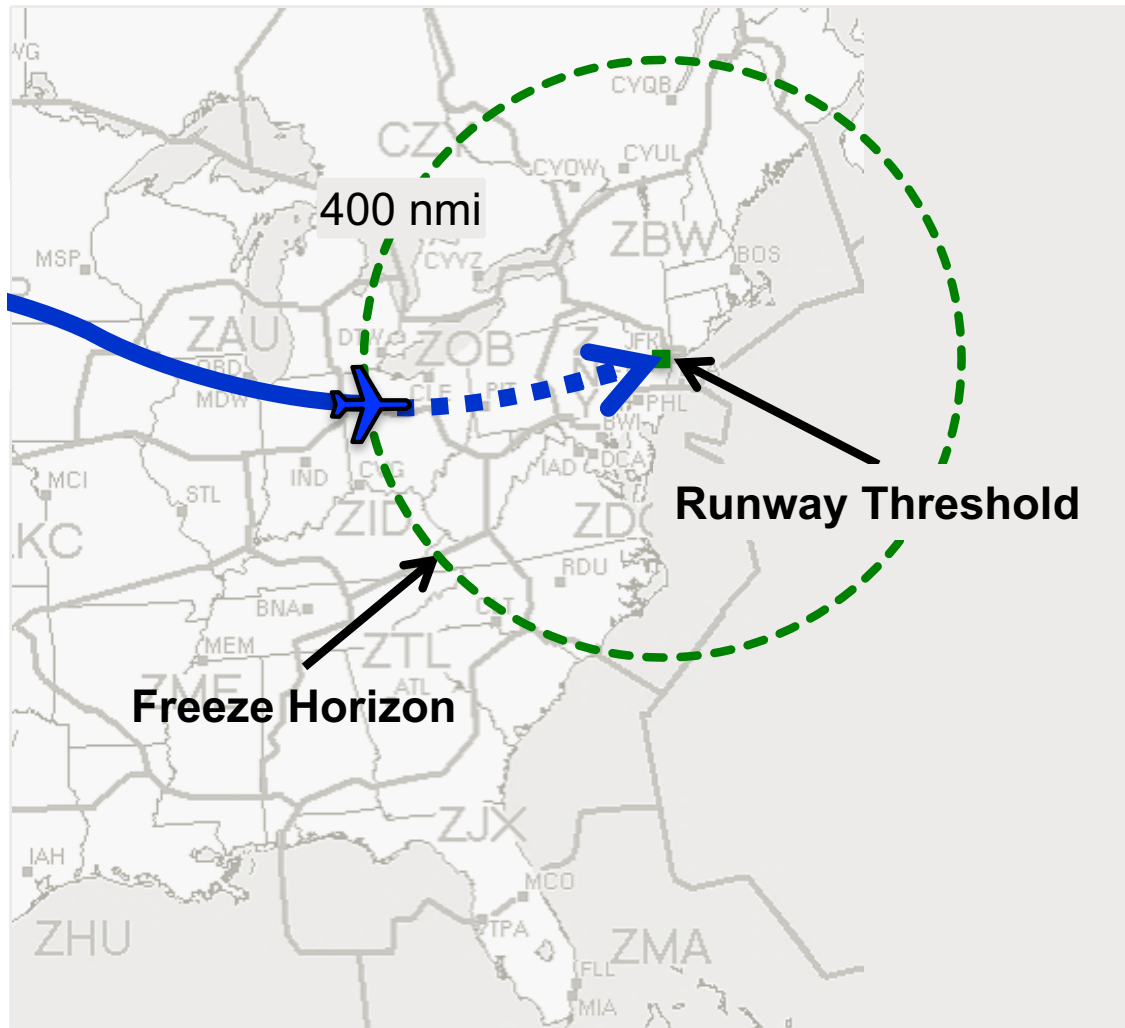


Expected
Time

Scheduled
Time

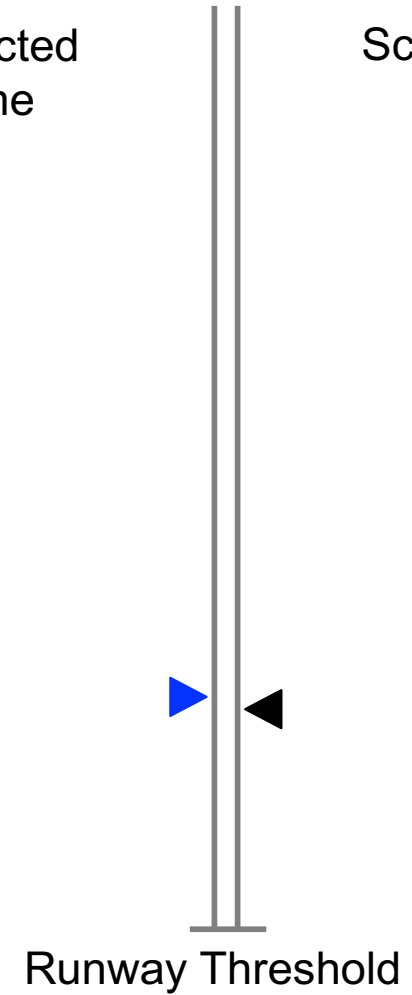


Tactical planning

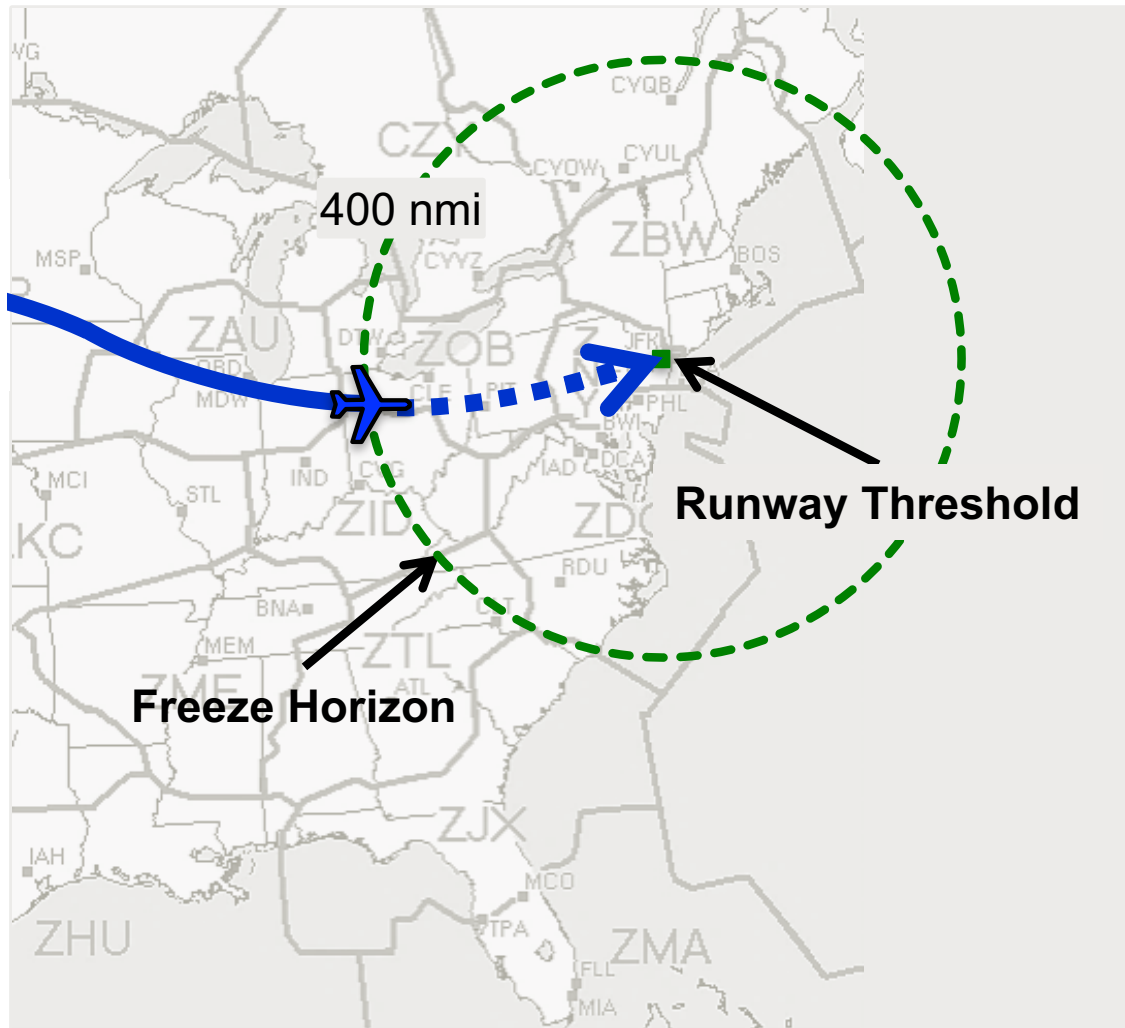


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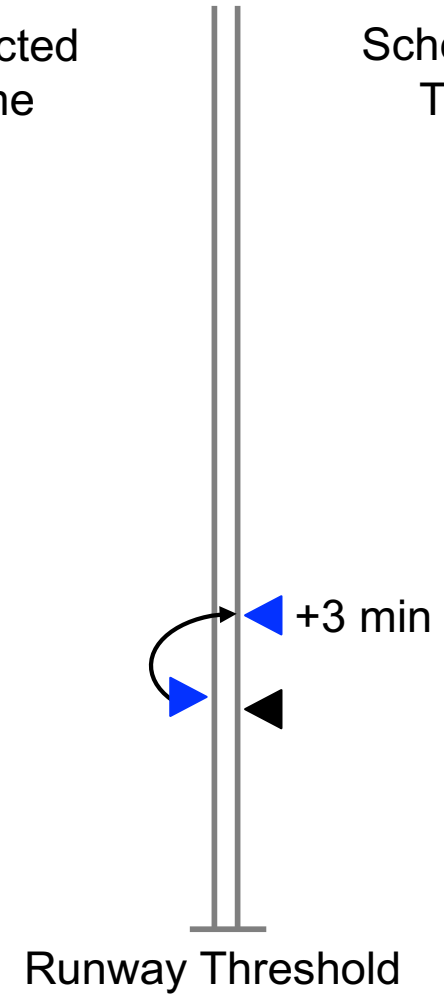


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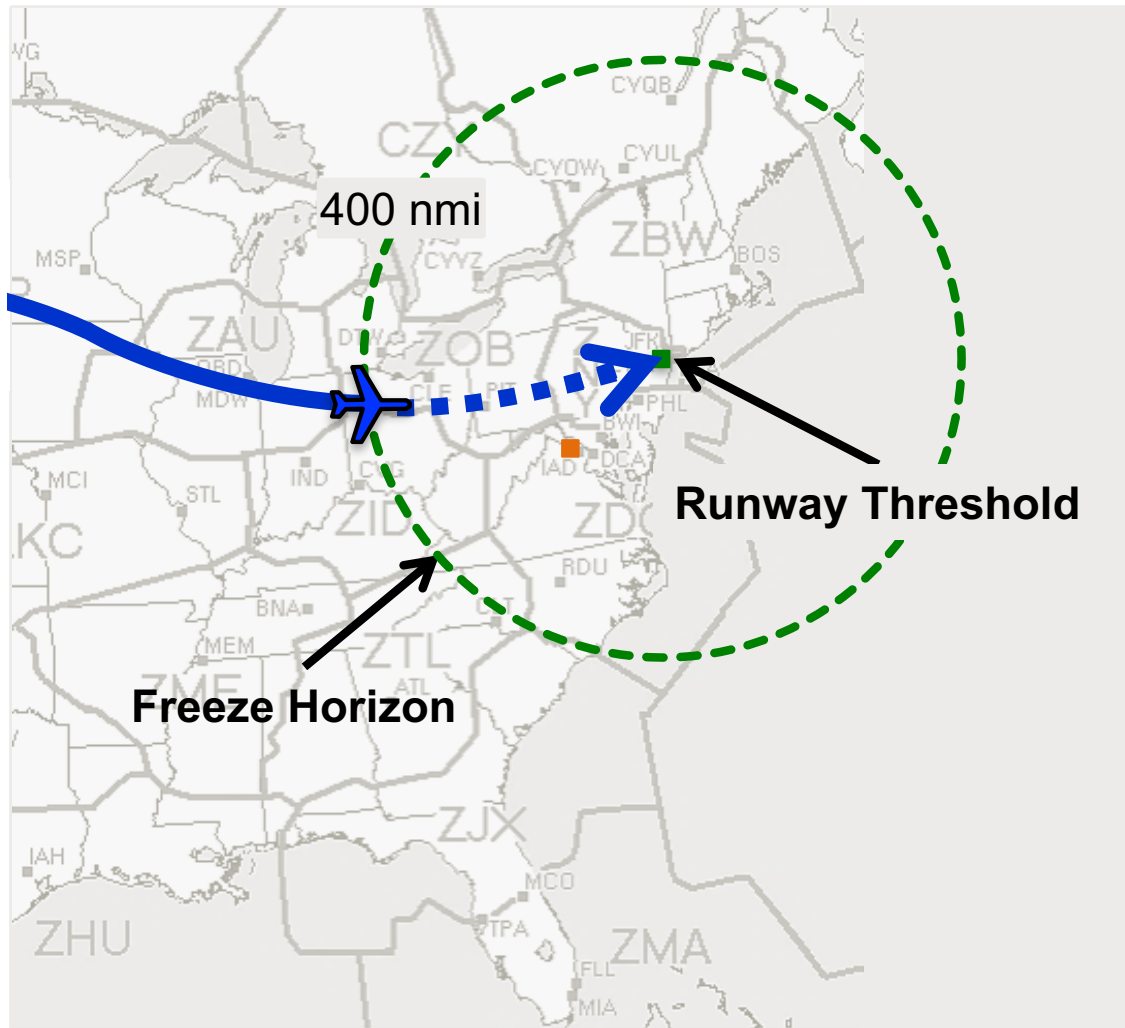


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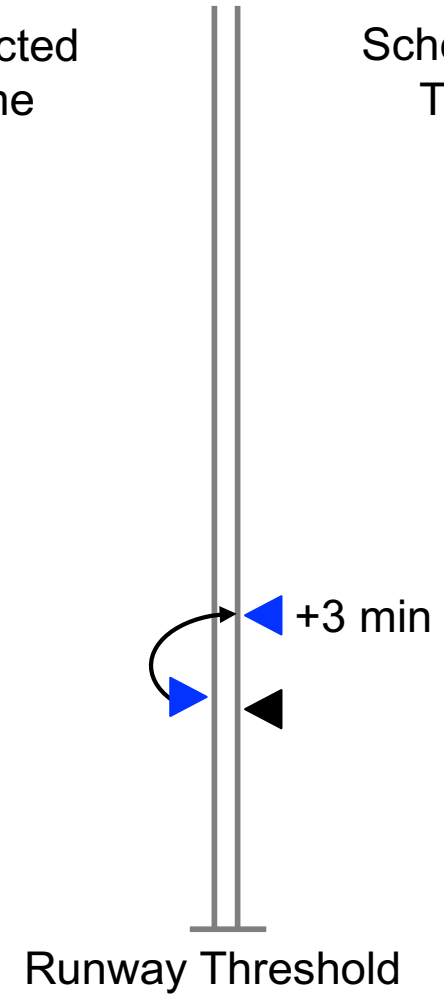


Tactical planning



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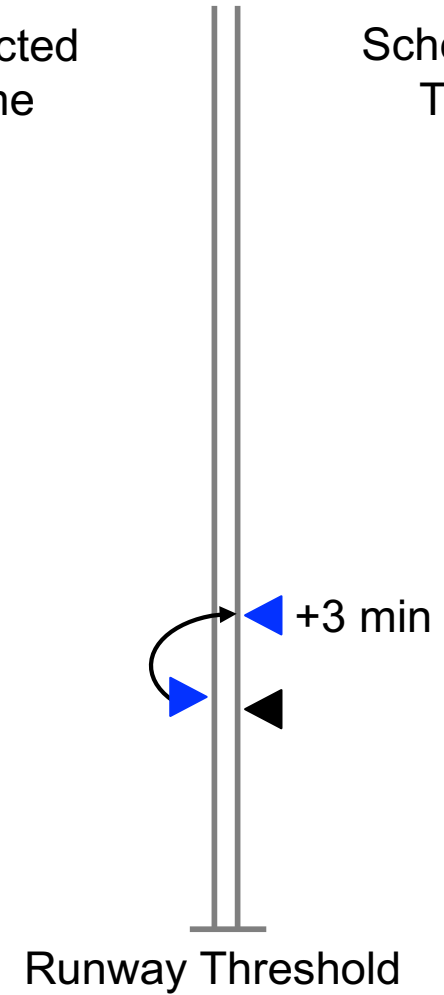


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Expected Time

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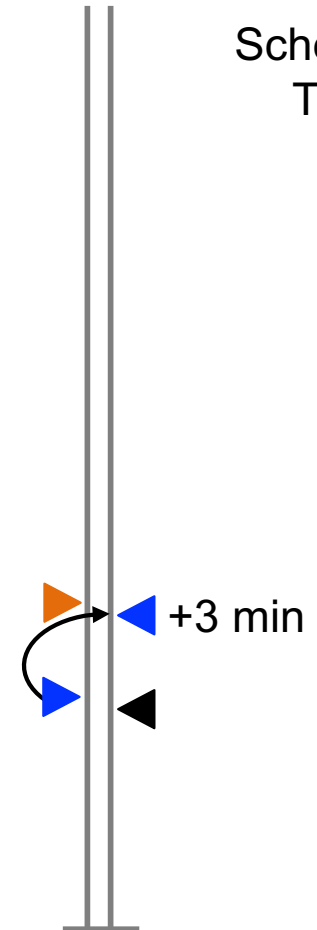


Tactical planning



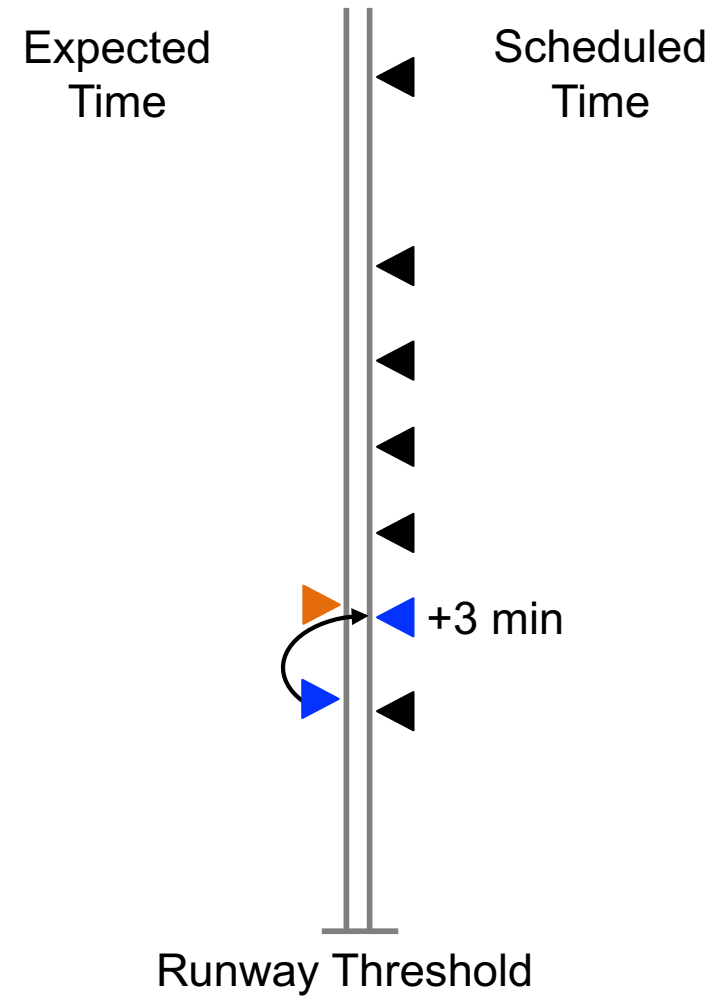
Expected
Time

Scheduled
Time



Runway Threshold

Tactical planning



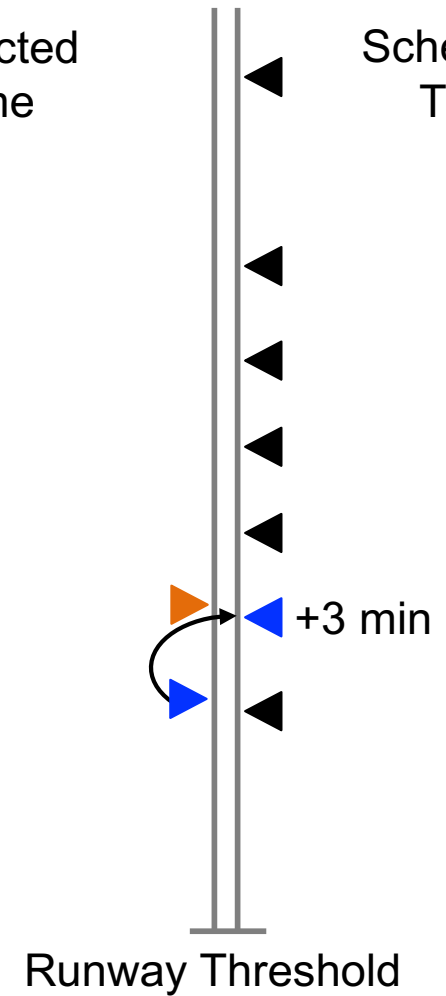
Tactical planning



Priority to airborne flights

Expected Time

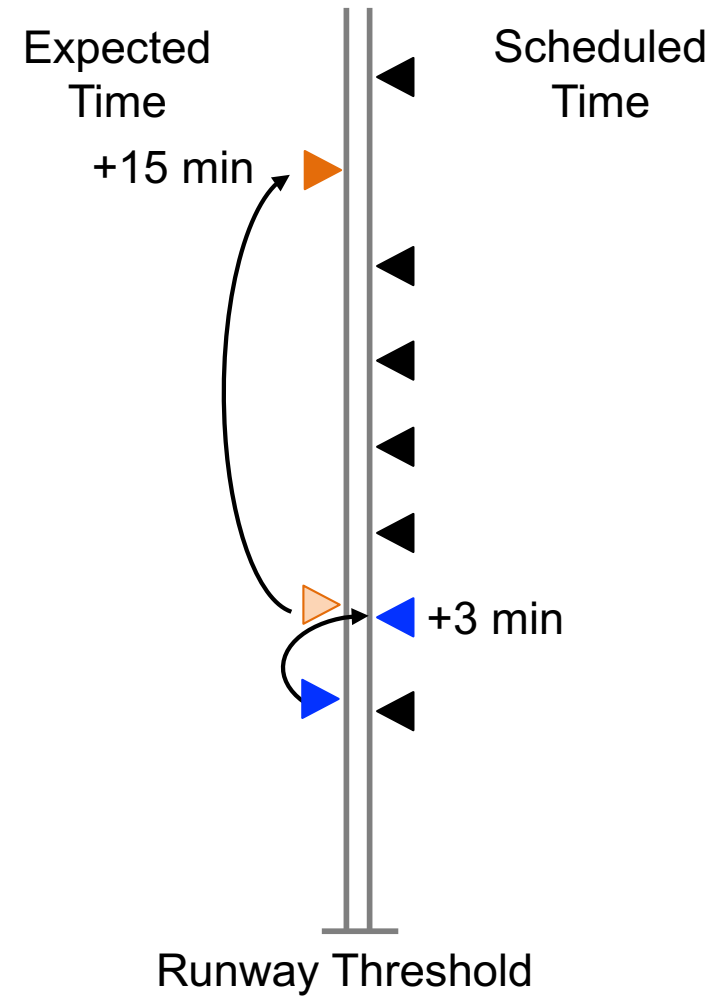
Scheduled Time



Tactical planning



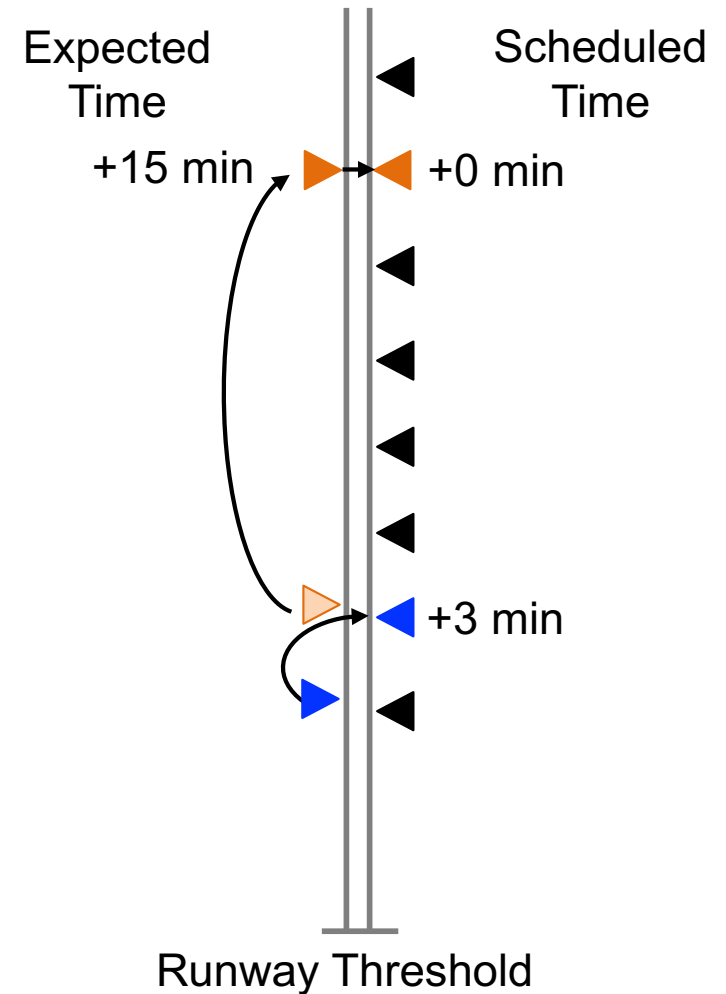
Priority to airborne flights



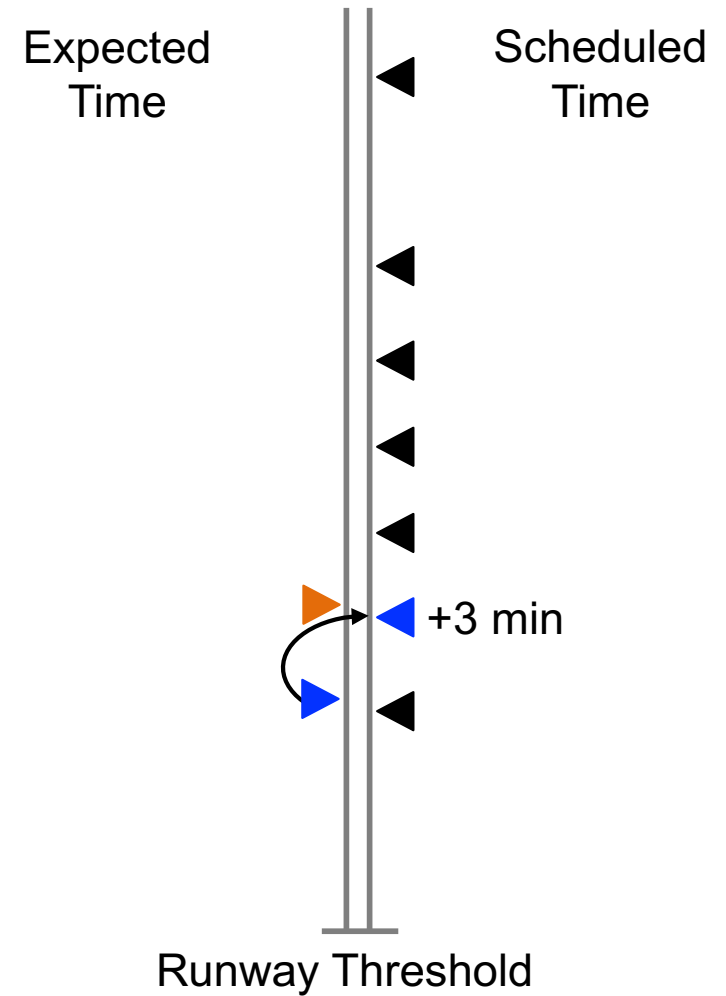
Tactical planning



Priority to airborne flights



Tactical planning



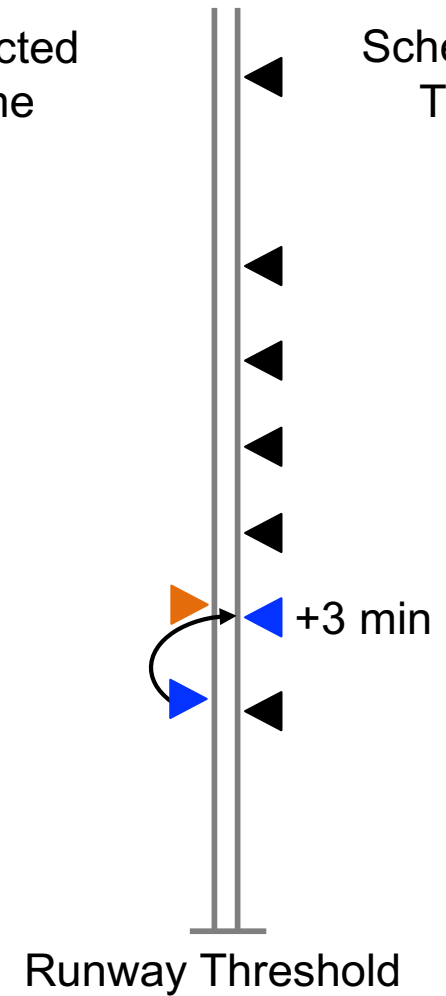
Tactical planning



Priority to internal departures

Expected Time

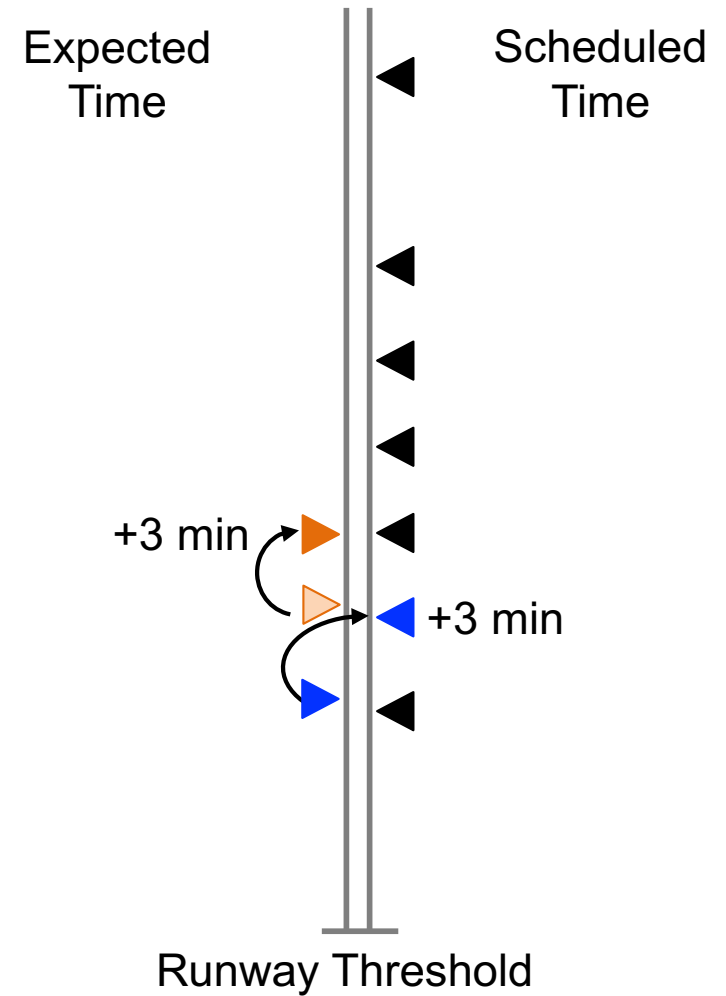
Scheduled Time



Tactical planning



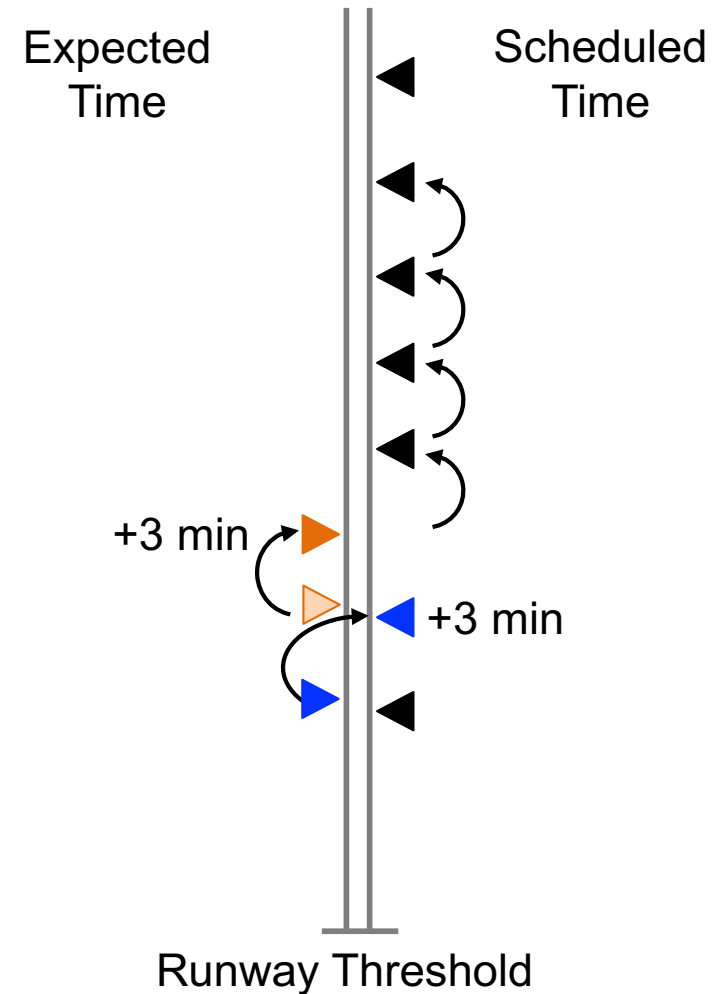
Priority to internal departures



Tactical planning



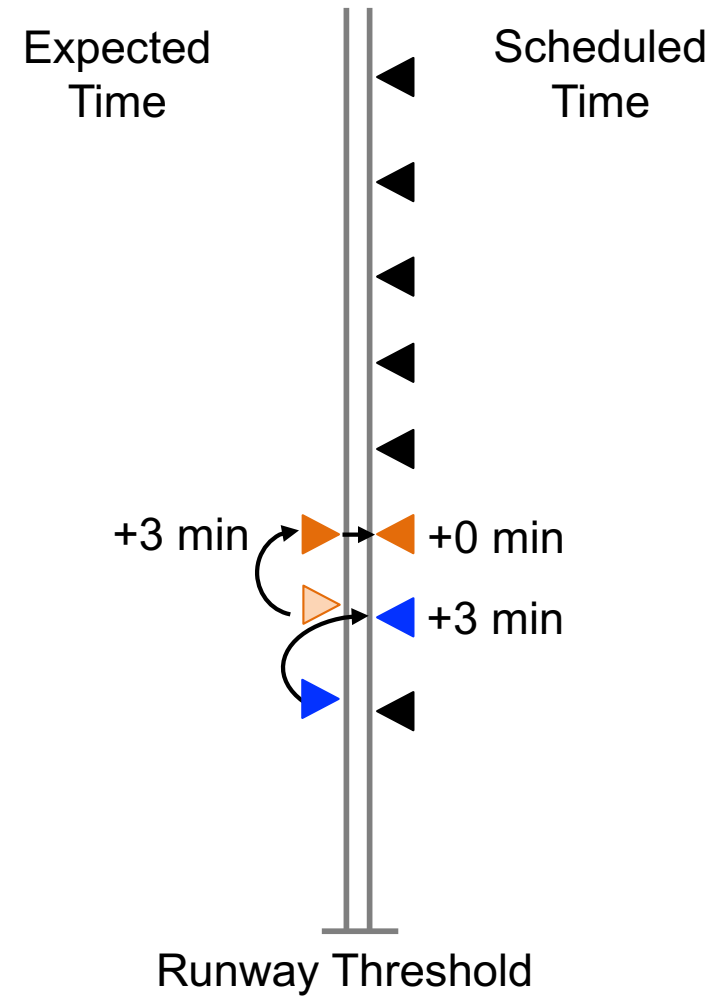
Priority to internal departures



Tactical planning



Priority to internal departures



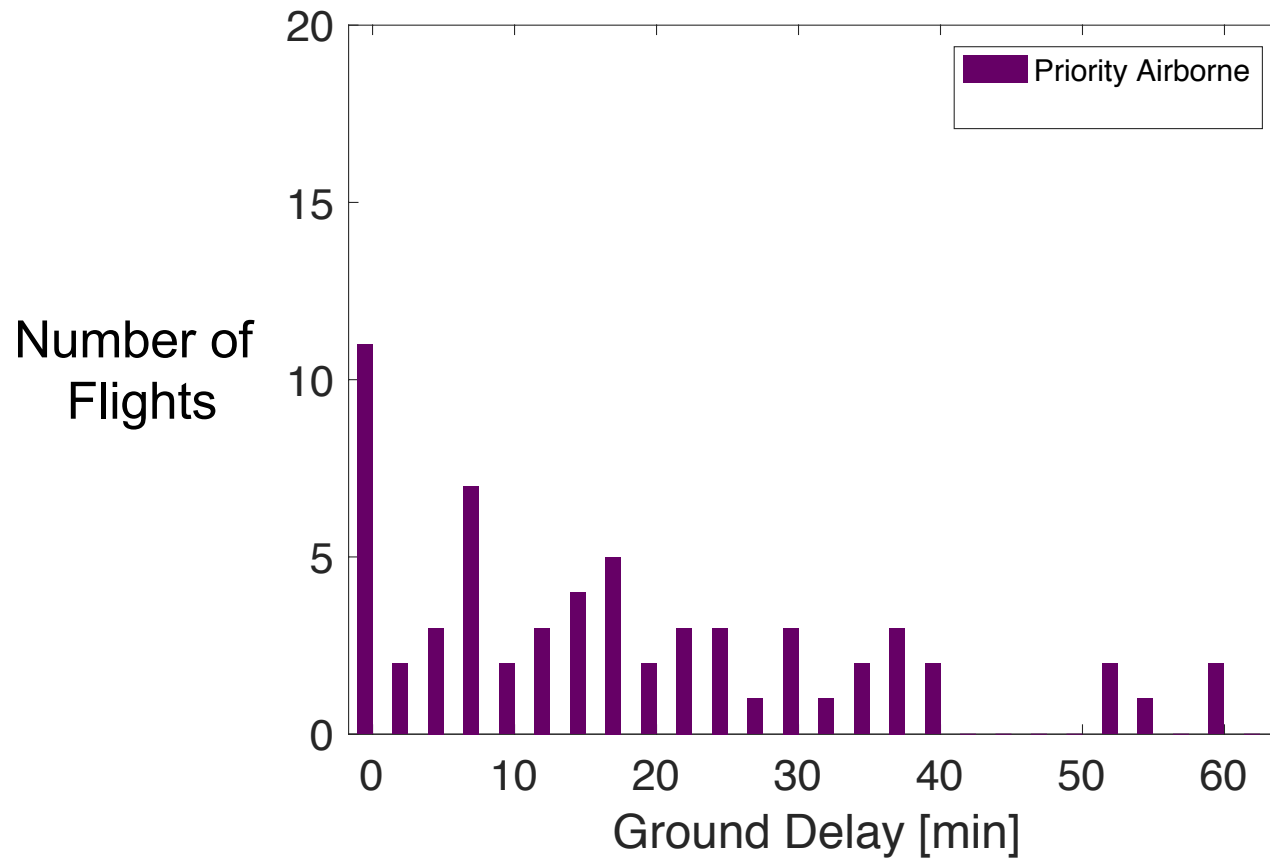
Experimental setup

- Duration of 5 hours
- 253 flights
 - 98 airborne at simulation start
 - 91 external departures
 - 64 internal departures
- Flights depart with some error
- Tactical scheduling paradigms
 - Priority given to airborne flights
 - Priority given to internal departures

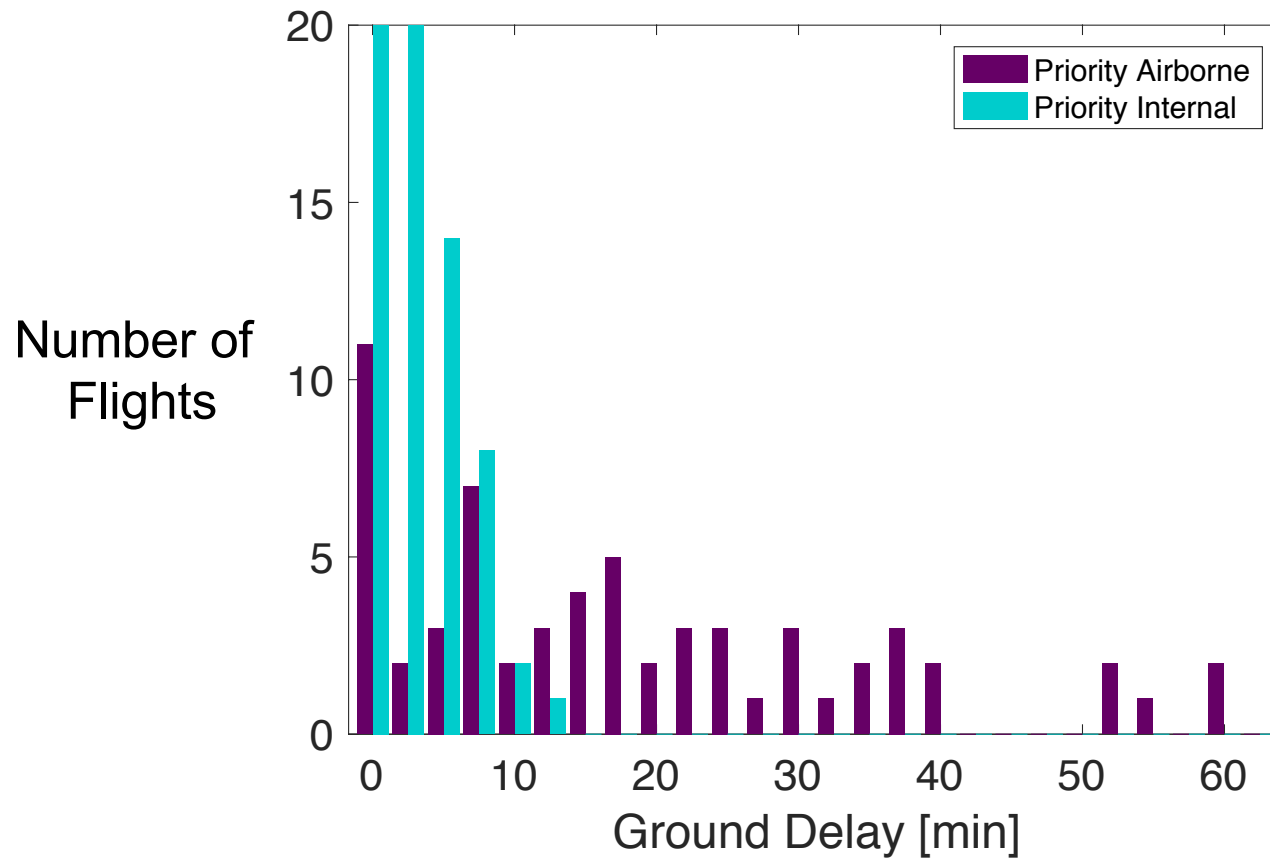
Expected results

- Generate results *qualitatively* similar HITL
- HITL simulations have shown:
 - Priority given to airborne flights
 - ⇒ Relatively high ground delay for internal departures
 - Priority given to internal departures
 - ⇒ Significant reduction in ground delay for internal departures
 - ⇒ Required airborne delay is manageable

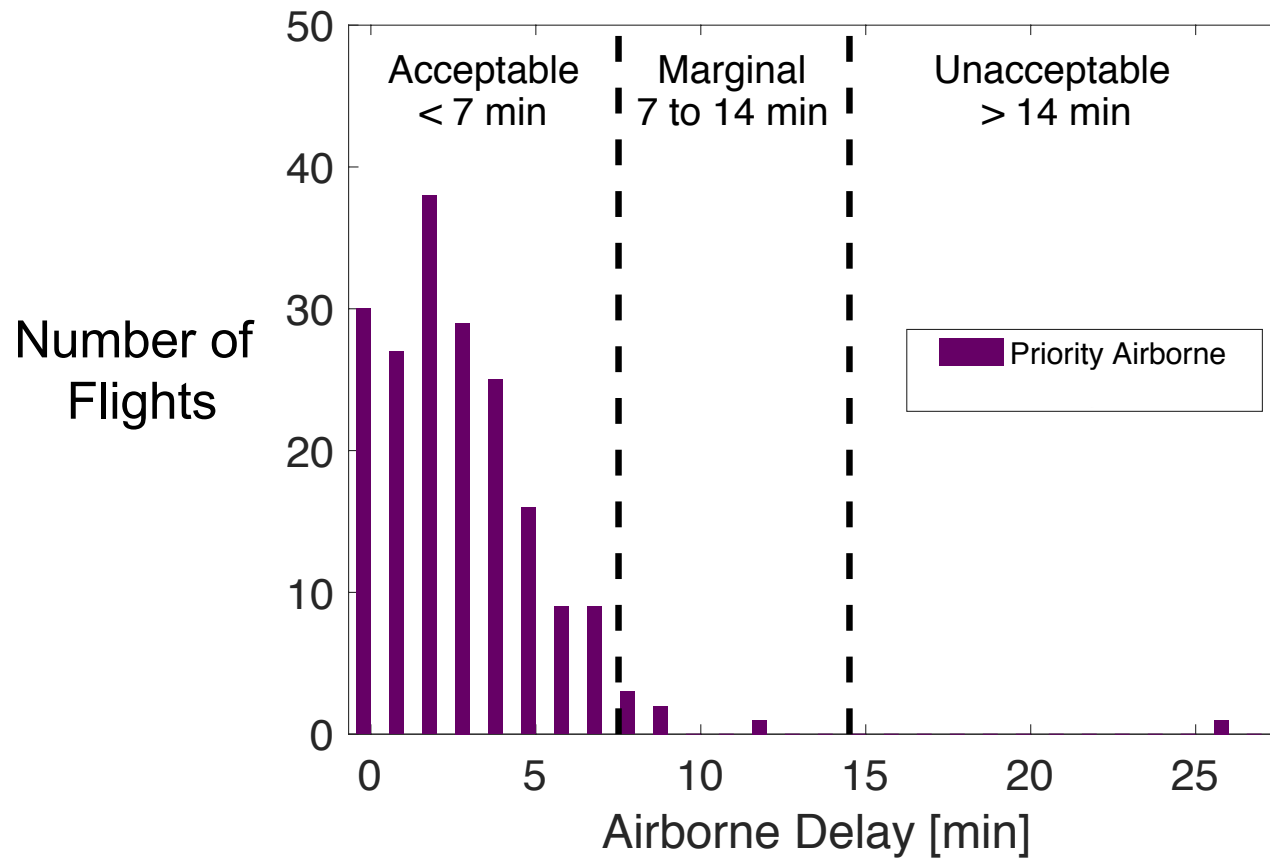
Internal departure ground delay



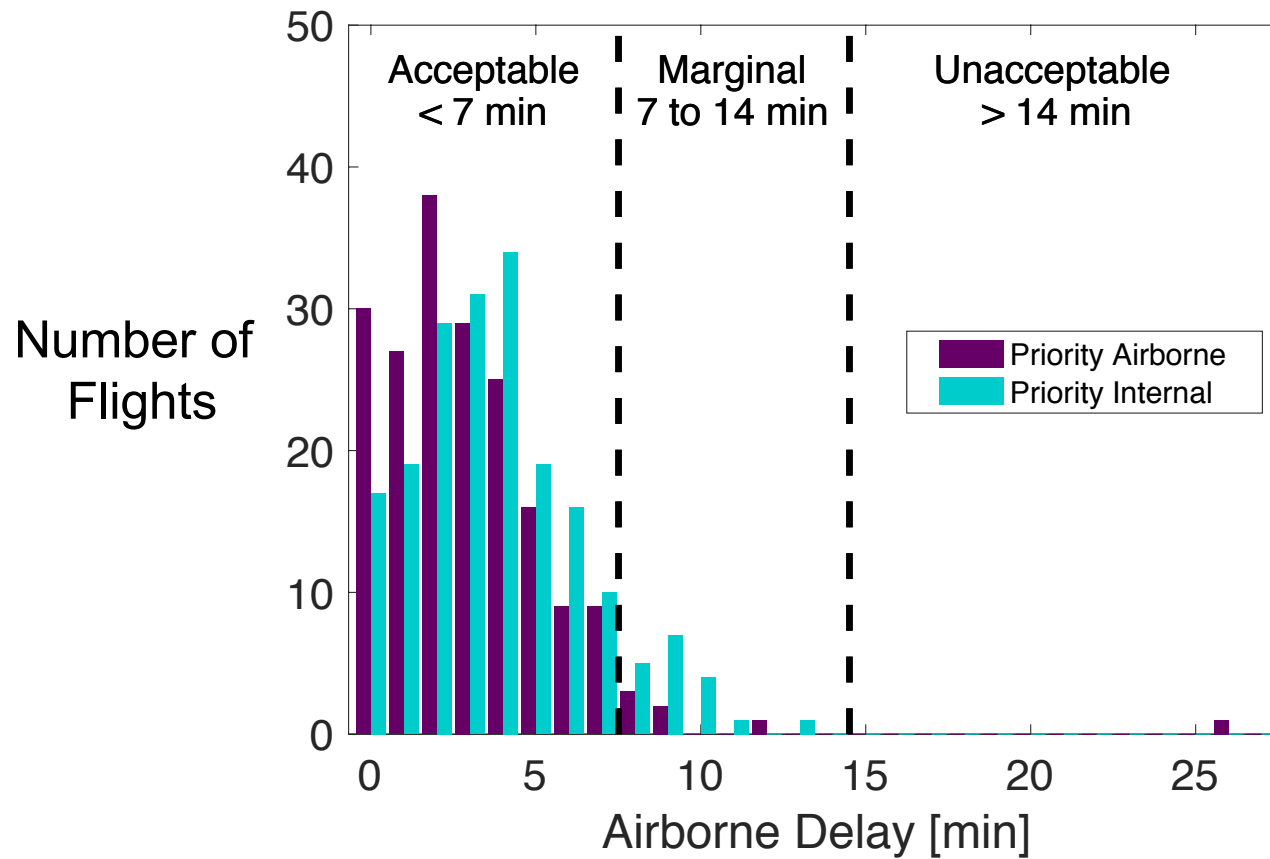
Internal departure ground delay



Airborne delay



Airborne delay



Comparison to HITL simulation

| Tactical Scheduling Paradigm | Simulation | Tactical Airborne Delay | | |
|------------------------------|------------|-------------------------|---------------------|------------------------|
| | | Acceptable (<7 min) | Marginal (7-14 min) | Unacceptable (>14 min) |
| Priority Internals | HITL | 82 % | 17 % | 1 % |
| | Automated | 87 % | 13 % | 0 % |
| Priority Airborne | HITL | | | |
| | Automated | 94 % | 5 % | 1 % |

Comparison to week-long HITL

| | HITL | Automated | Automated fast-time (5x) |
|------------------------|-------------|------------------|---------------------------------|
| Subject matter experts | 320 hours | 0 hours | 0 hours |
| Simulation technician | 32 hours | 1 hour | 1 hour |
| Number of simulations | 4 | 20 | 104 |
| Active Simulation Time | 20 hours | 100 hours | 104 hours |

Automated simulation capability

- Automate HITL simulation
- Emulate HITL simulation results
- Maintain high fidelity trajectory simulation
- Incorporate updates to strategic planning tool

Automated simulation capability

- Automate HITL simulation
- Emulate HITL simulation results
- Maintain high fidelity trajectory simulation
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Benefits

- Evaluate over larger variation in parameters
- Simulate larger, more realistic traffic scenarios
- Augment HITL by automated background traffic

Development

- Add other New York airports:
 - LaGuardia Airport (LGA)
 - John F. Kennedy International Airport (JFK)
- Augment HITL simulations with more traffic
- Enable fast-time simulation (up to 5x real-time)

Research

- Parameter studies
- Uncertainty in departure and flight time



Backup



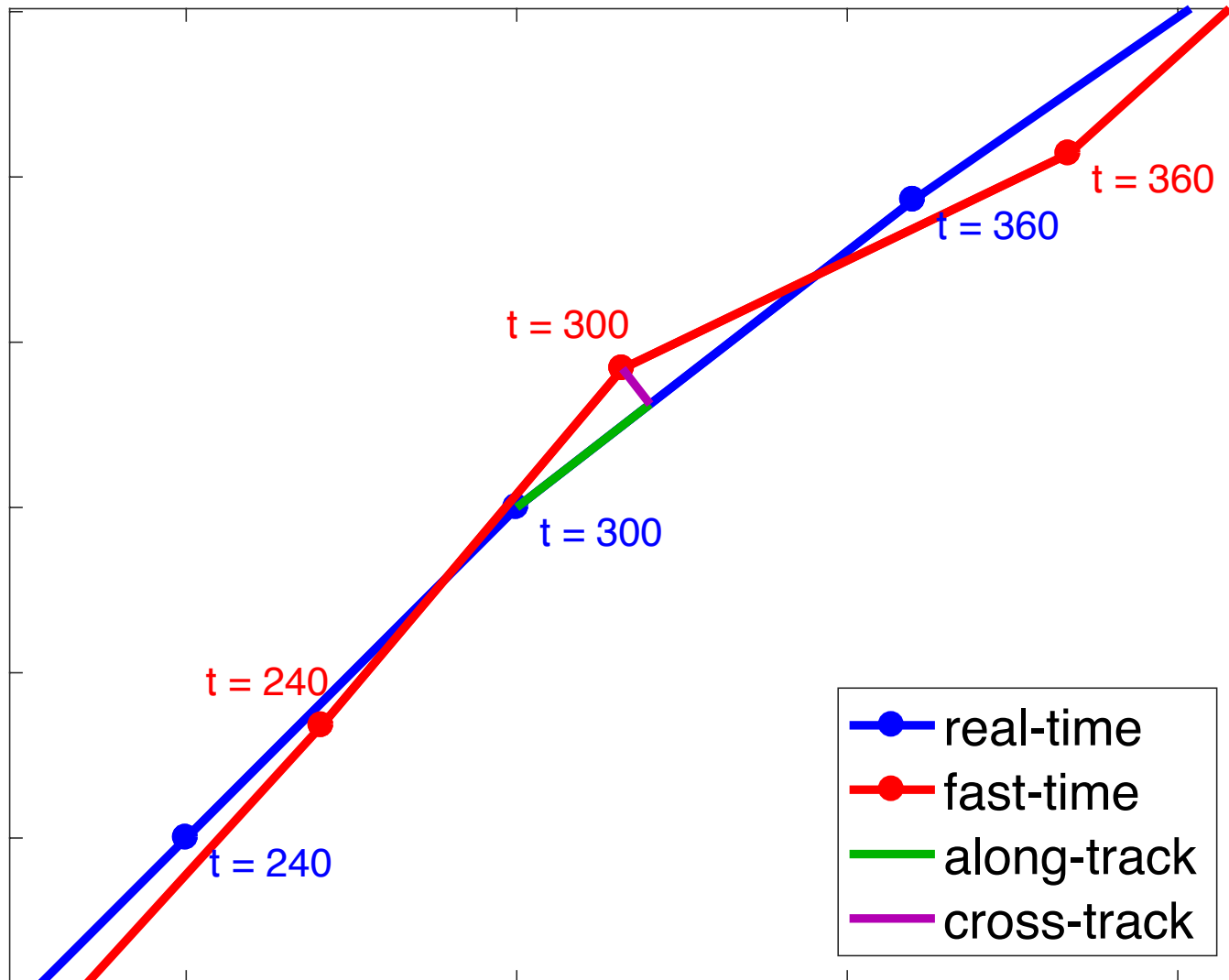
Fast Time MACS



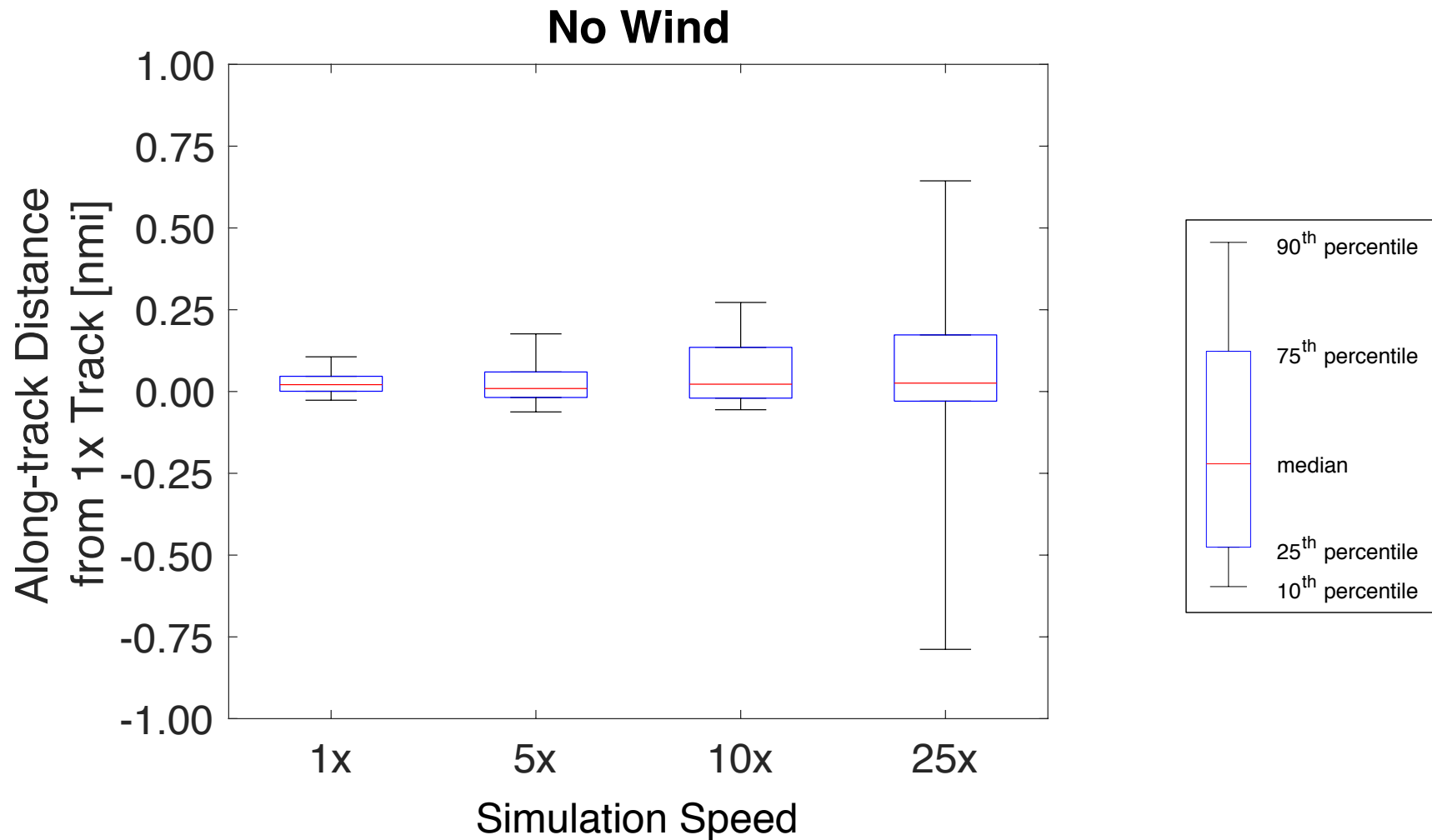
Fast time MACS

- Flights analyzed: 196
- FlightState data output from MACS
- Trajectory information every 12 seconds
- Resampled in 1 minute intervals
(for 1x reference sim and 1x, 5x, 10x, 25x sim)

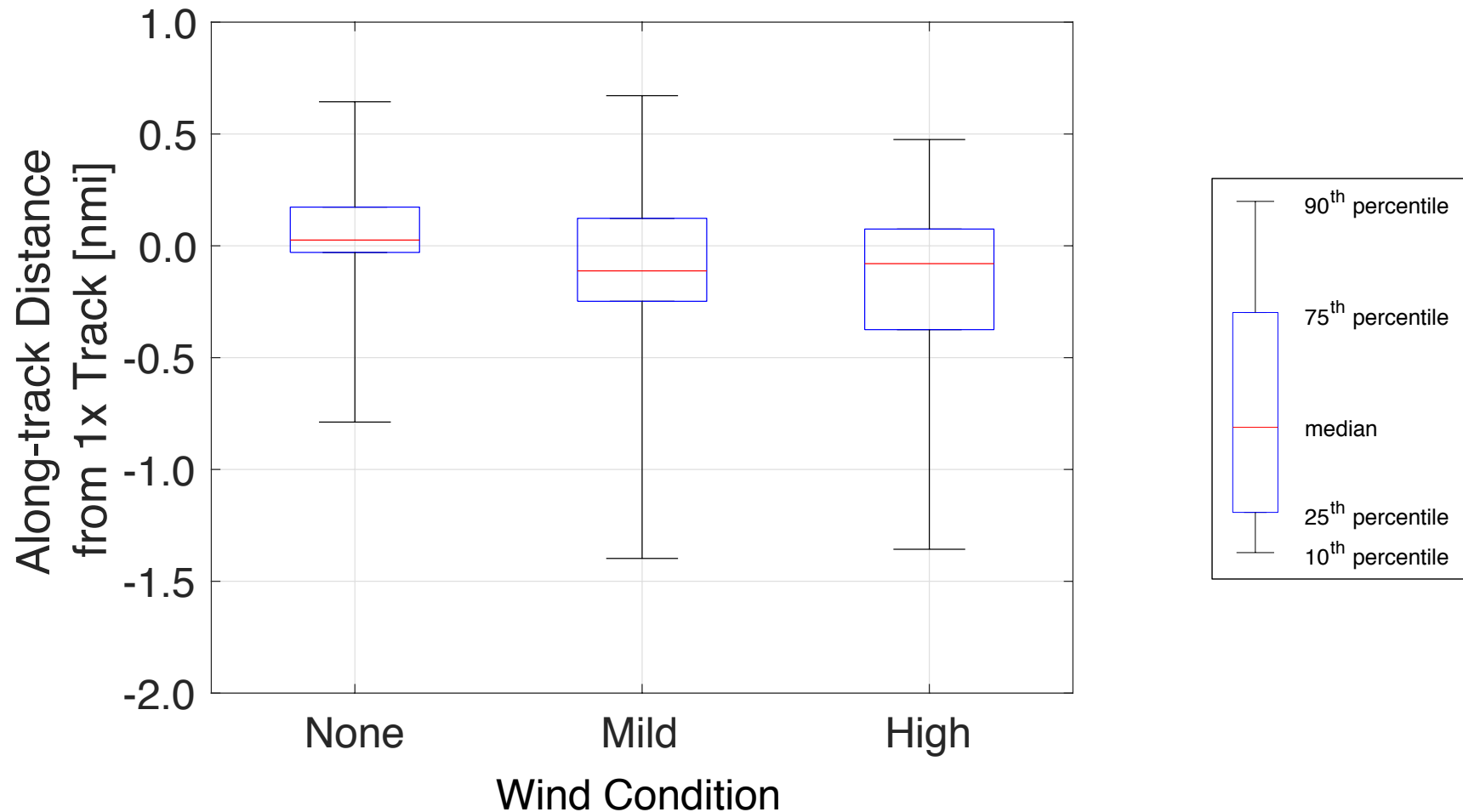
Distance measure



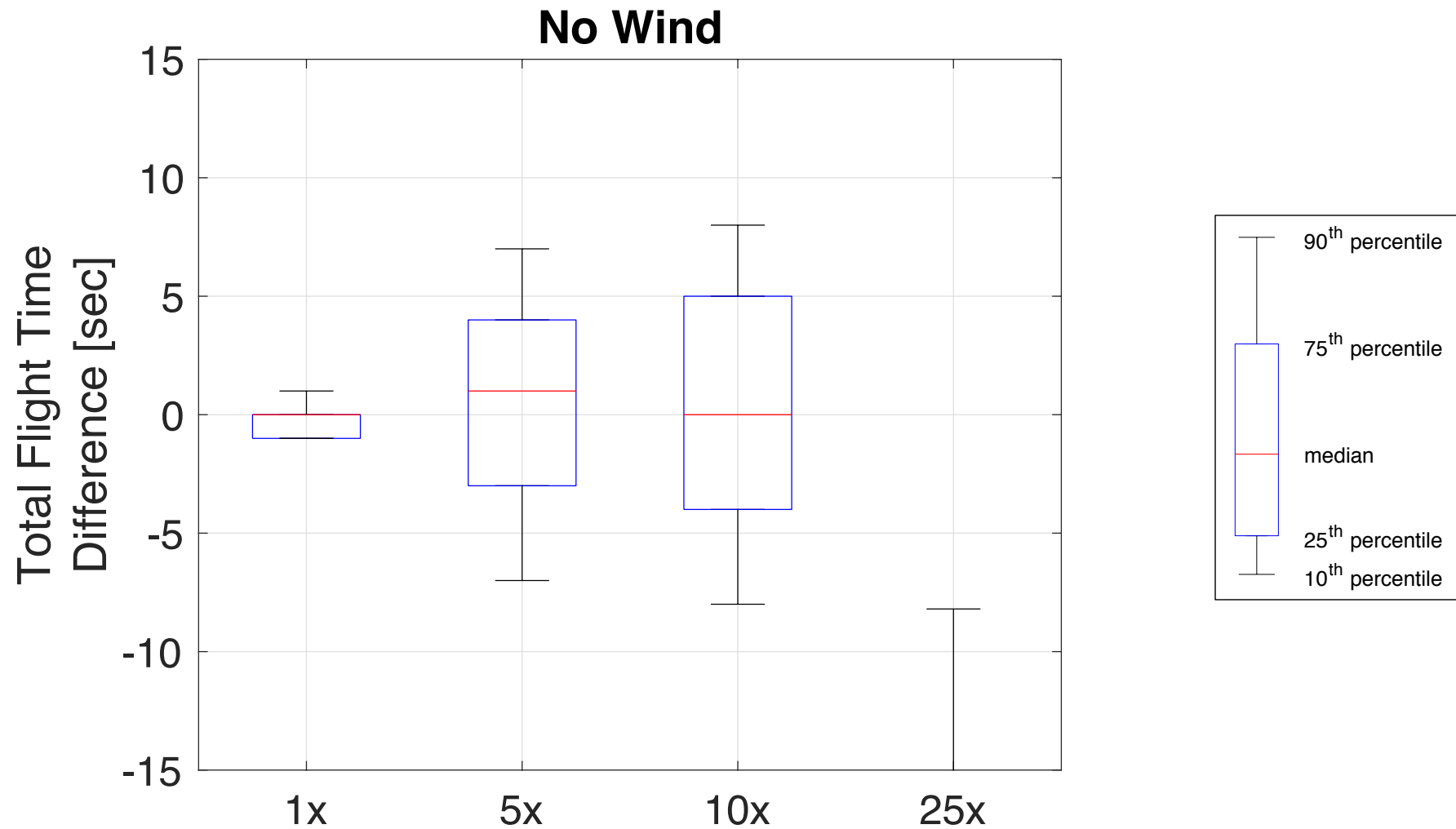
Along-track distance



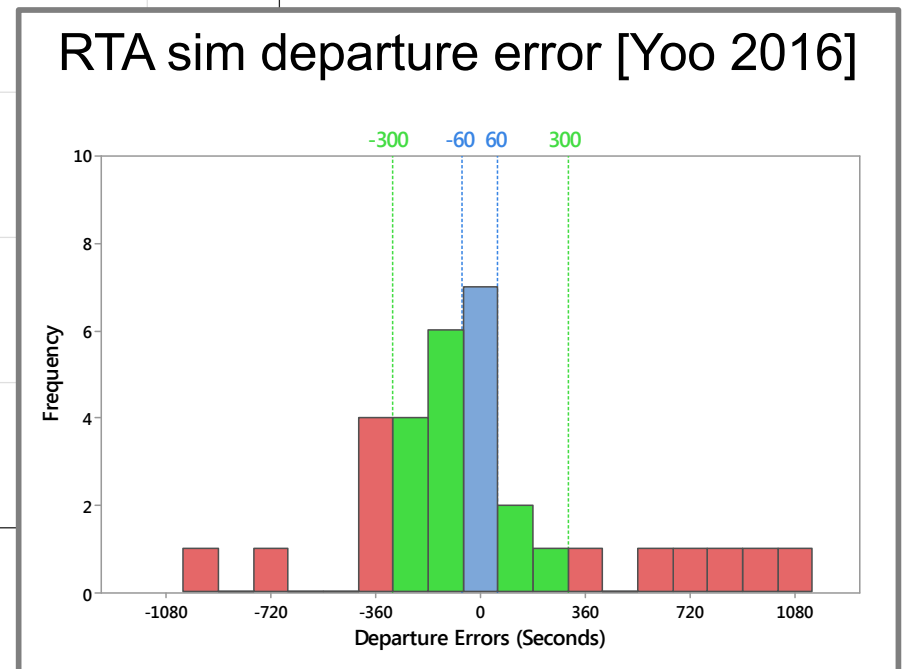
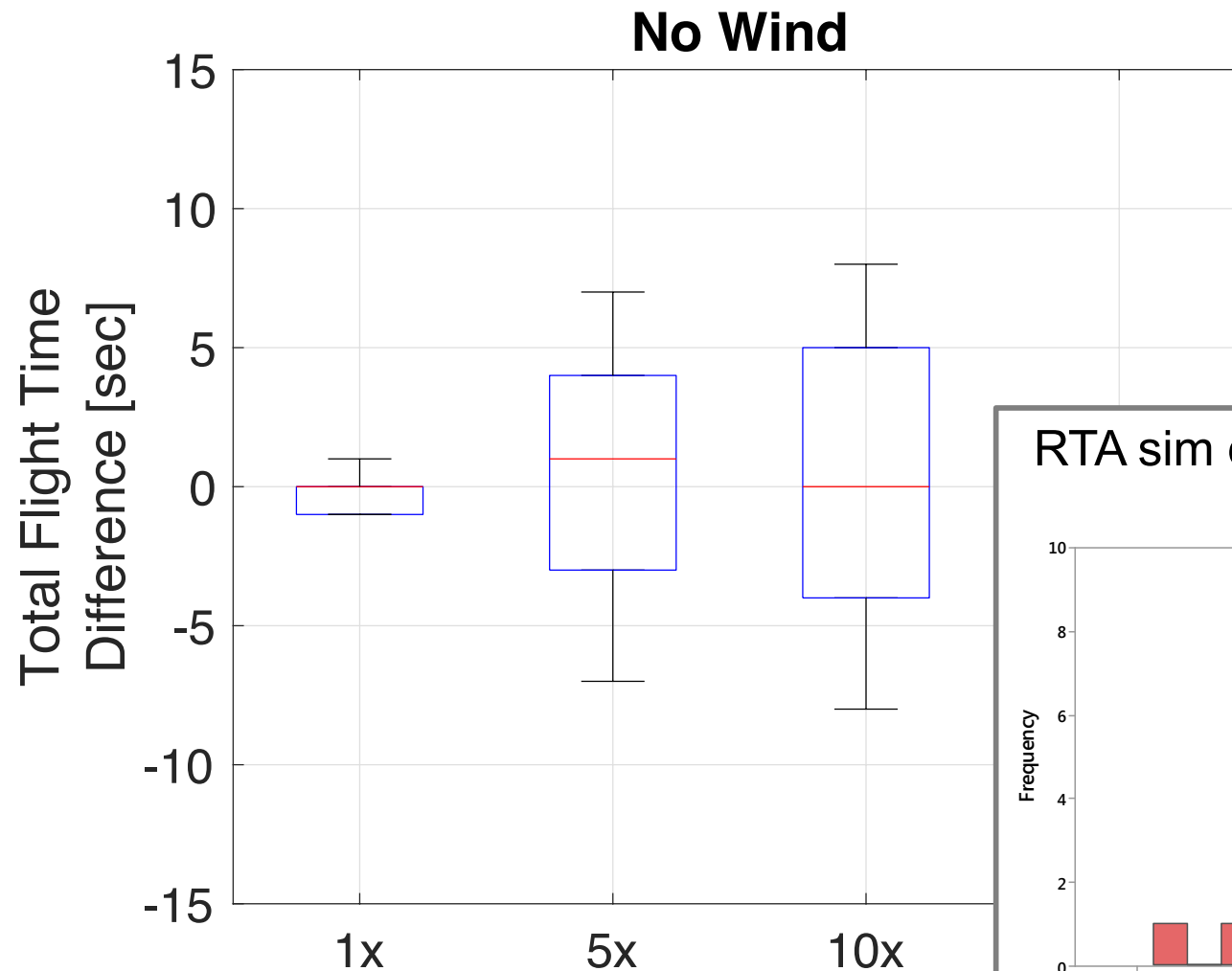
With wind, 25x: along-track distance



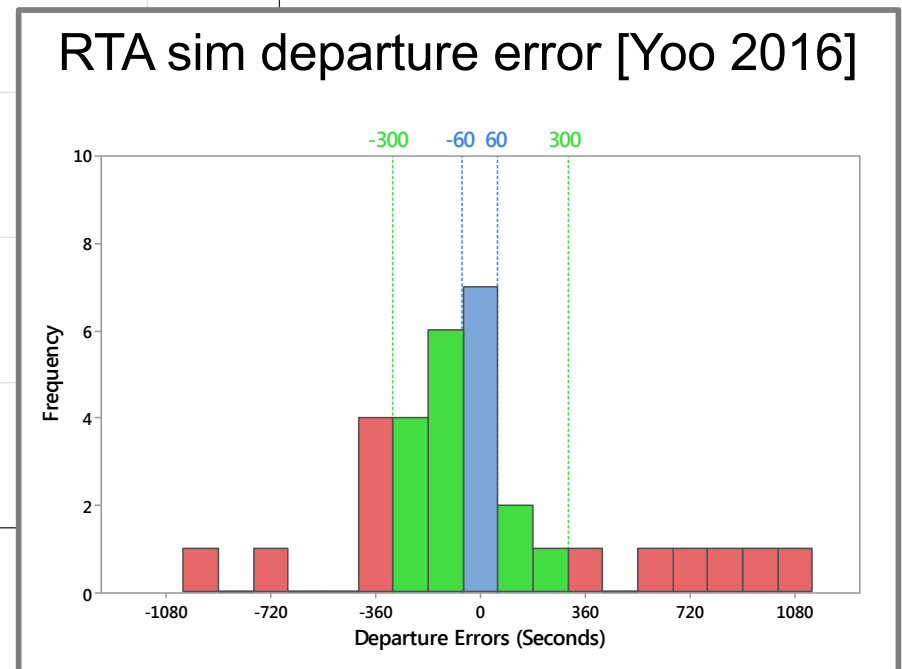
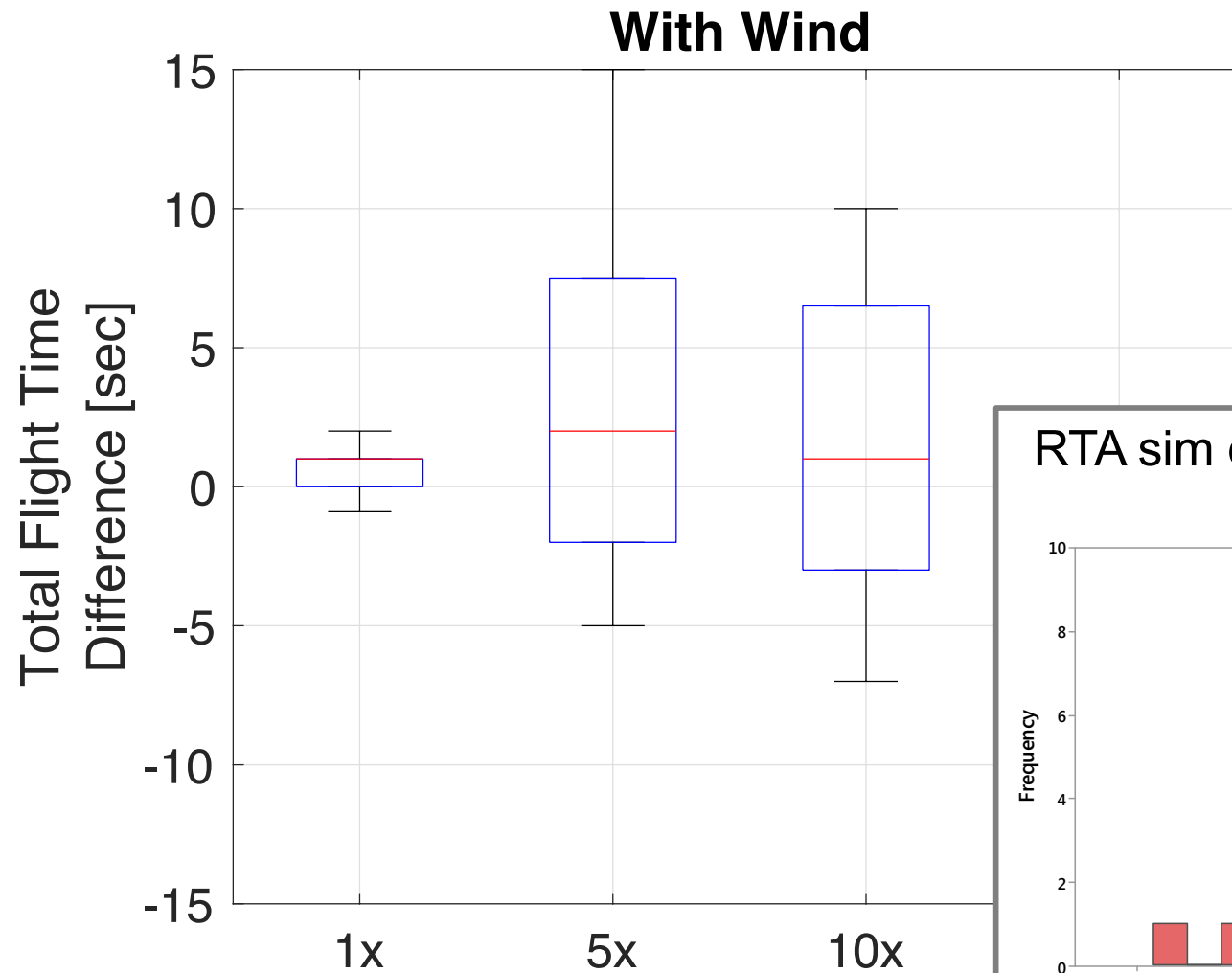
Flight time difference



Flight time difference



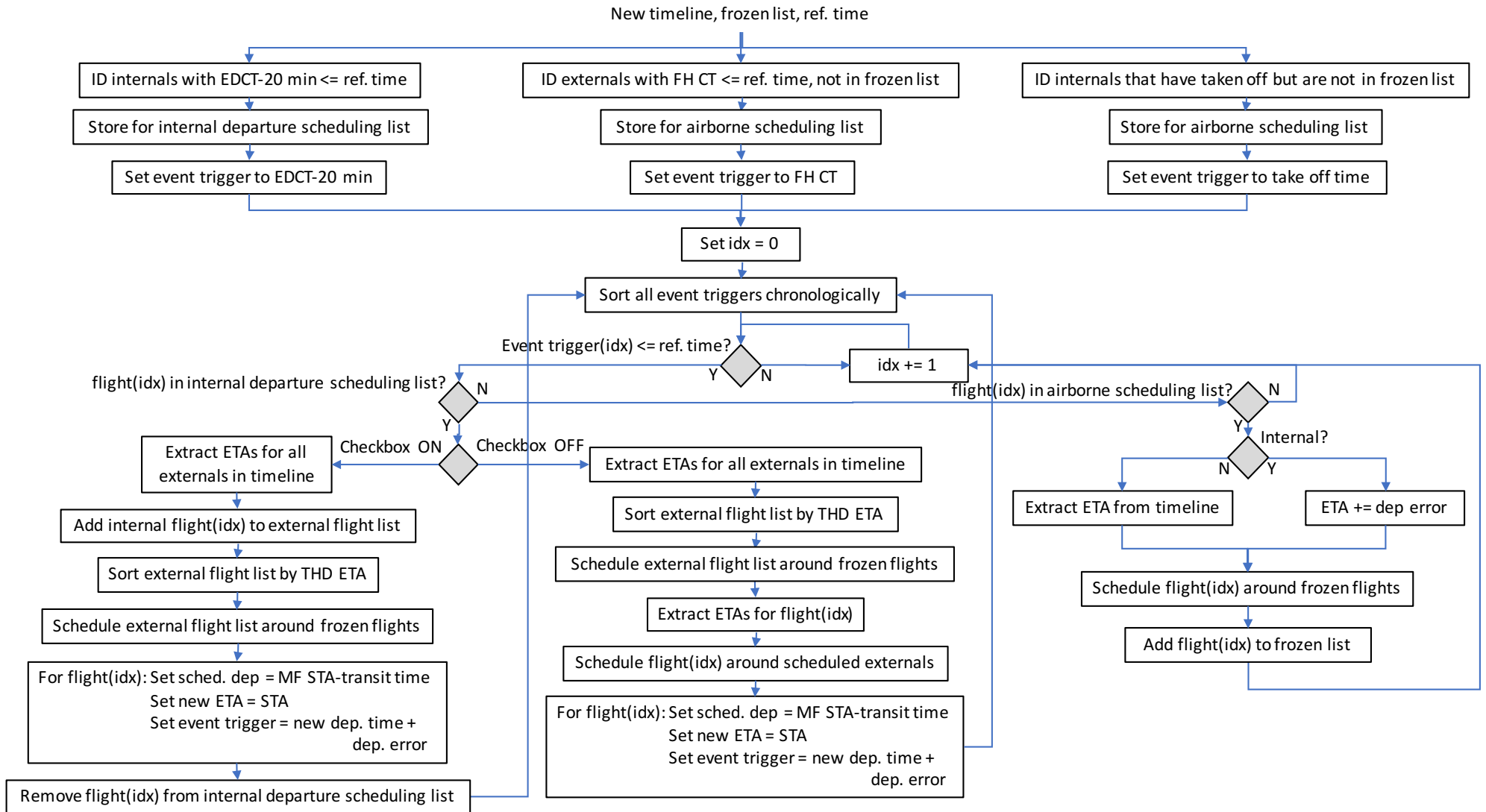
Flight time difference



TBFM Emulator



Scheduling internal departures



TBFM Emulator

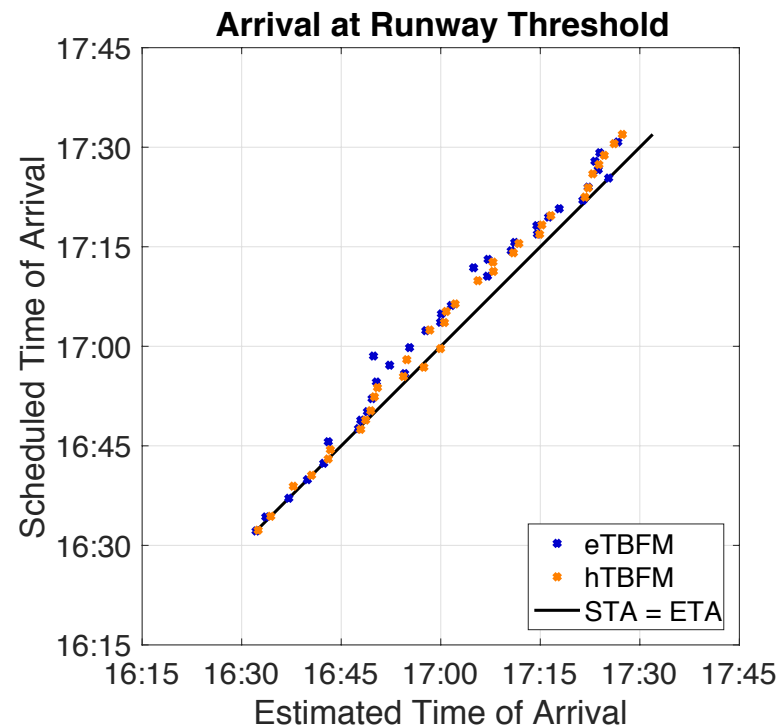
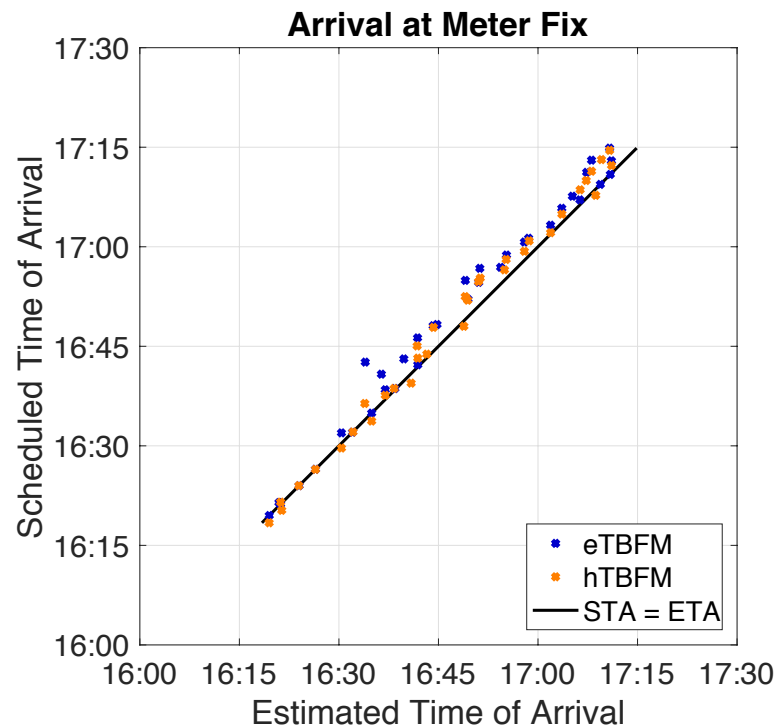
- Scheduler from Optimized Route Capability (ORC)
 - Fast-time
 - Code easily accessible for modification
- Adapted for EWR
- Modified to schedule internal departures automatically
 - Check box ON/OFF
- Integrated with Automated Simulation Capability / MACS

TBFM Emulator Capabilities

| Capability | rTBFM | eTBFM |
|--|-------|---------|
| Fast-time | | ✓ |
| EWR adaptation | ✓ | ✓ |
| Schedule flights at Meter Fix | ✓ | ✓ |
| Schedule flights at Runway Threshold | ✓ | ✓ |
| Schedule flights at Final Approach Fix | ✓ | Planned |
| Model wind effects inside TRACON | ✓ | Planned |
| Model wind effects upstream of TRACON | ✓ | ✓ |
| Automated scheduling of internal departures (Check Box ON/OFF) | | ✓ |
| Extended metering | ✓ | Planned |
| Coupled scheduling | ✓ | |
| Integrated with Automated Simulation Capability / MACS | | ✓ |
| Interface directly with SMART-NAS Testbed | | Planned |

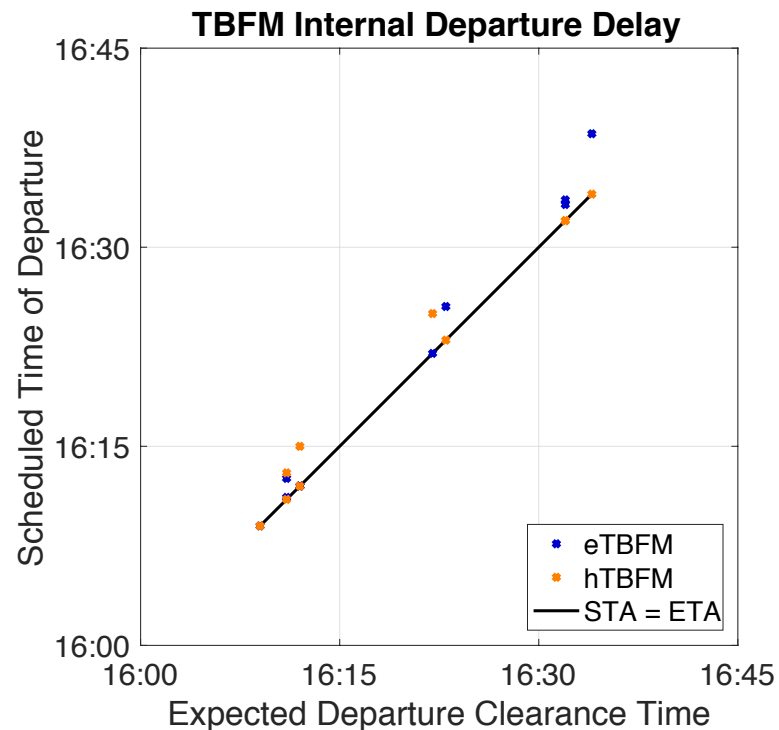
Initial validation: ORC scheduler

| | Meter Fix | | Threshold | |
|---|-----------|-------|-----------|-------|
| | [Seconds] | | | |
| Avg. hTBFM metering delay (standard deviation) | 80 | (104) | 136 | (106) |
| Avg. eTBFM emulator metering delay (standard deviation) | 143 | (131) | 180 | (135) |
| Avg. ETA Error: hTBFM-eTBFM (standard deviation) | 19 | (75) | 52 | (77) |
| Avg. STA Error: hTBFM-eTBFM (standard deviation) | -43 | (104) | 7 | (100) |



Initial validation: TBFM emulator

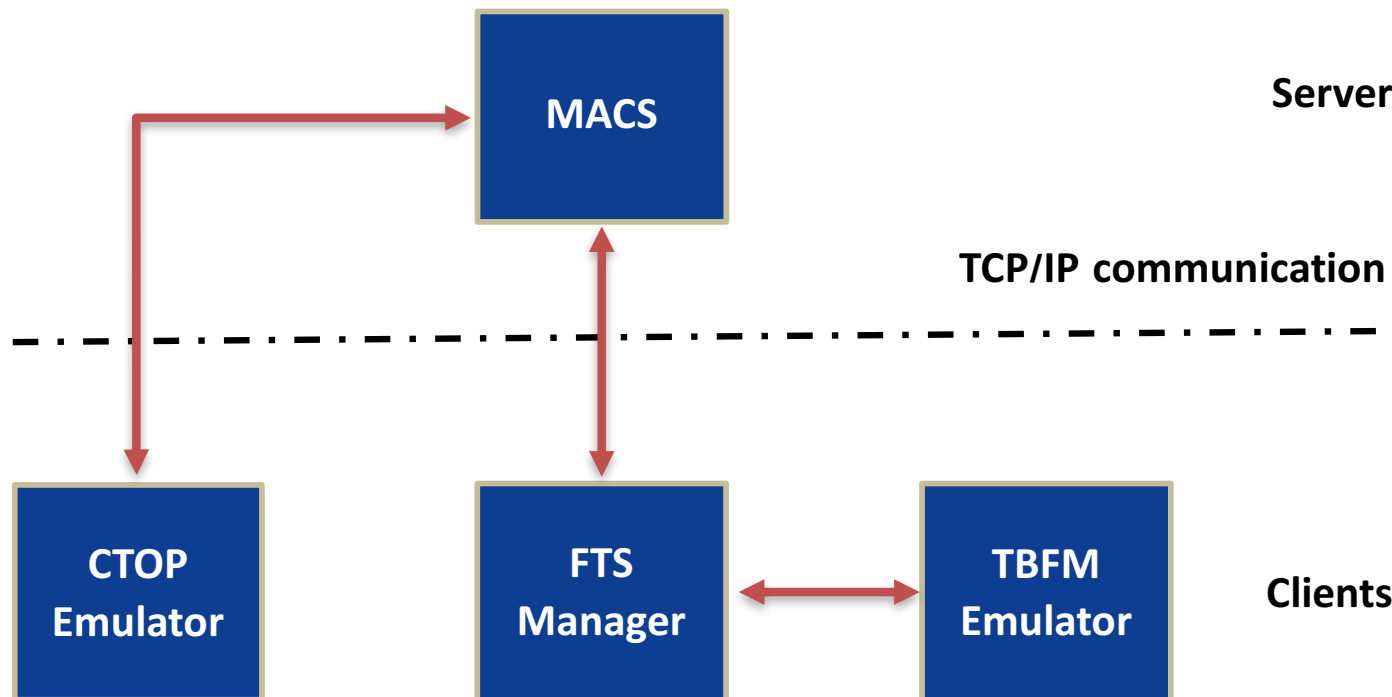
| | [Seconds] | |
|---|-----------|-------|
| Avg. rTBFM internal departure scheduling delay | 66 | (72) |
| Avg. eTBFM internal departure scheduling delay | 70 | (90) |
| Avg. scheduled departure time error (rTBFM-eTBFM) | -4 | (129) |



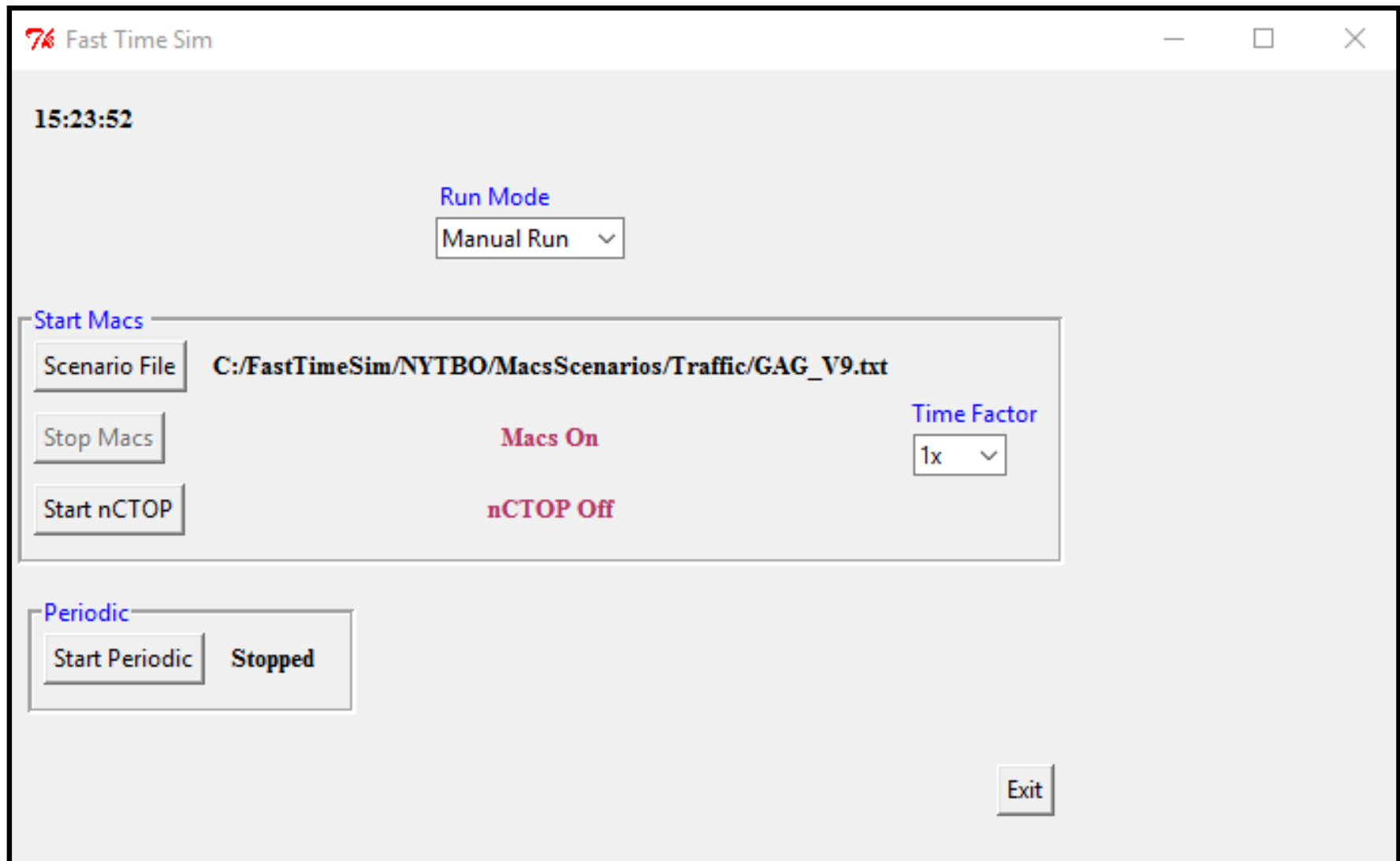
Simulation Manager



Simulation manager



Communication GUI



Demo



Create and run batch process

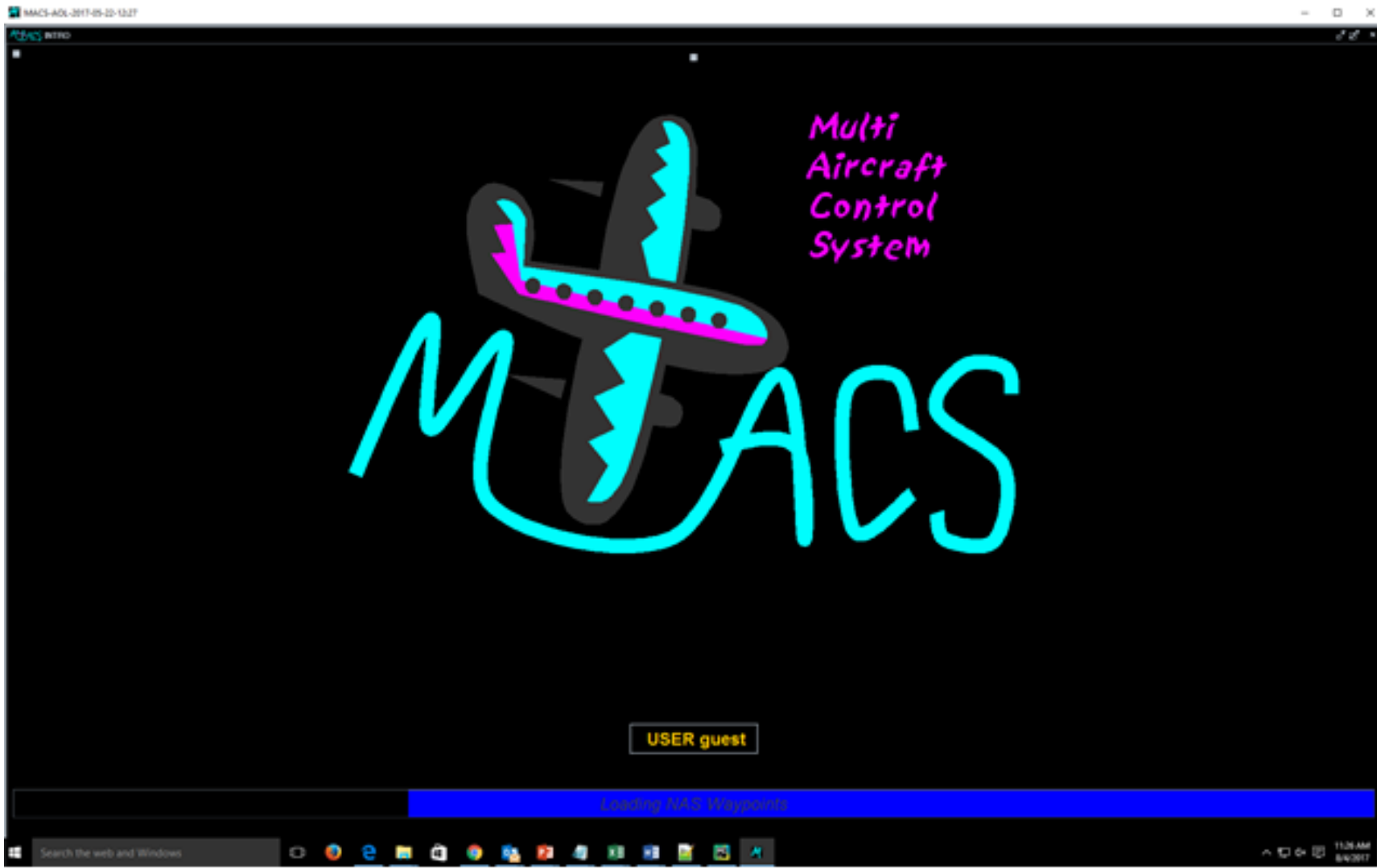
- Create batch file `FTS_bat.txt`

```
#RunName      Scenario      TimeFactor      RunMinutes      startnCTOPseconds
proc1 C:/fts-tbfm/input_files/EWR/Scenario/GAG_v9.txt      1x 30 10
proc2 C:/fts-tbfm/input_files/EWR/Scenario/MACS_20170421_1hr_traffic_NOdeperr.txt 1x 30 10
```

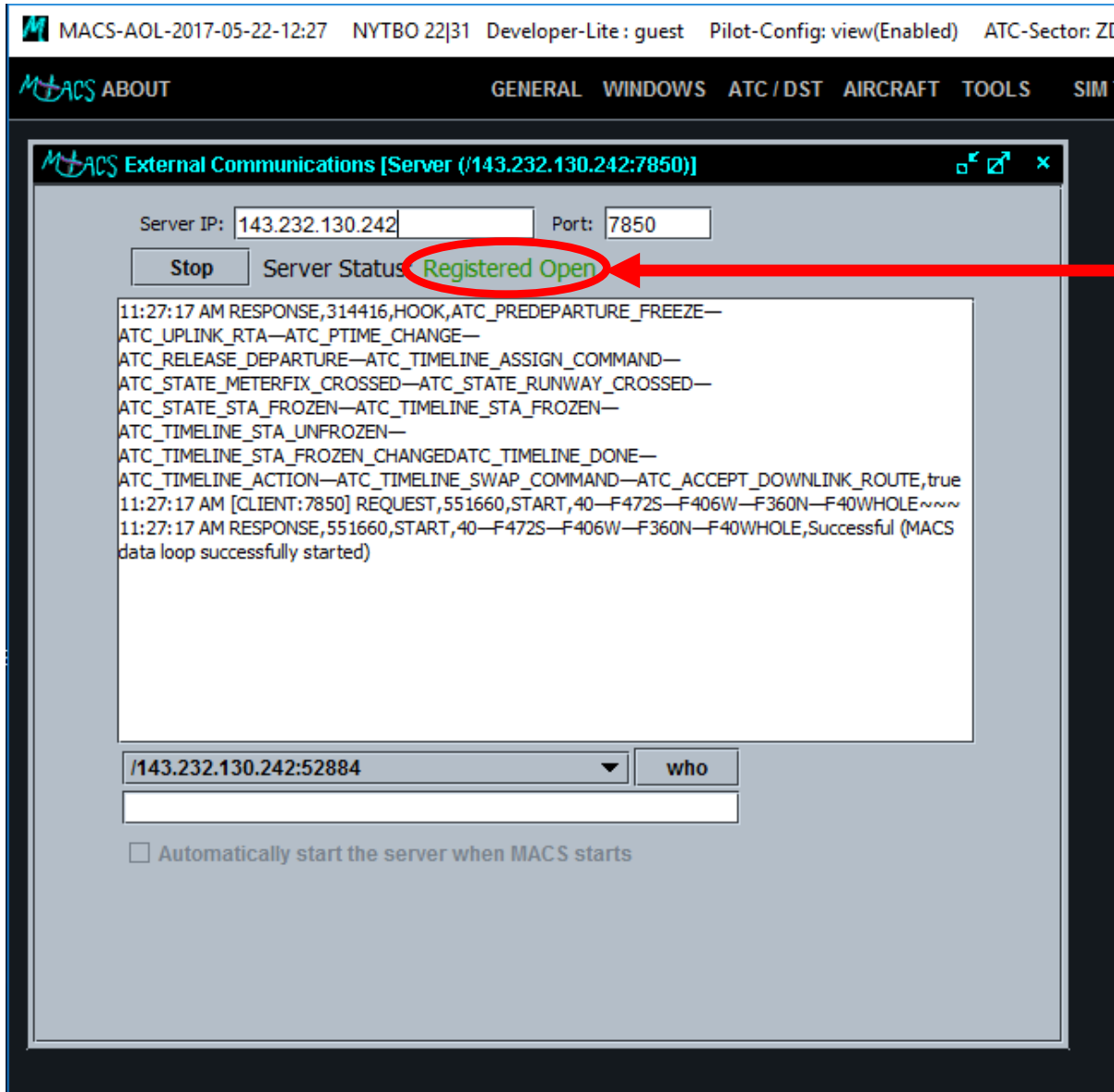
- Python command

```
Python FTS_Macs-batch.py FTS_bat.txt
```

Launch MACS



Enable external communication



The screenshot shows the MACS External Communications window for a server at IP 143.232.130.242 on port 7850. The window title is "MACS External Communications [Server (/143.232.130.242:7850)]". The "Server Status" is "Registered Open", which is circled in green and pointed to by a red arrow. The window contains a log of network traffic, including a successful data loop start. At the bottom, there is a dropdown menu showing "/143.232.130.242:52884" and a "who" button. A checkbox for "Automatically start the server when MACS starts" is present and unchecked.

MACS-AOL-2017-05-22-12:27 NYTBO 22|31 Developer-Lite : guest Pilot-Config: view(Enabled) ATC-Sector: ZD

MACS ABOUT GENERAL WINDOWS ATC / DST AIRCRAFT TOOLS SIM T

MACS External Communications [Server (/143.232.130.242:7850)]

Server IP: 143.232.130.242 Port: 7850

Stop Server Status: Registered Open

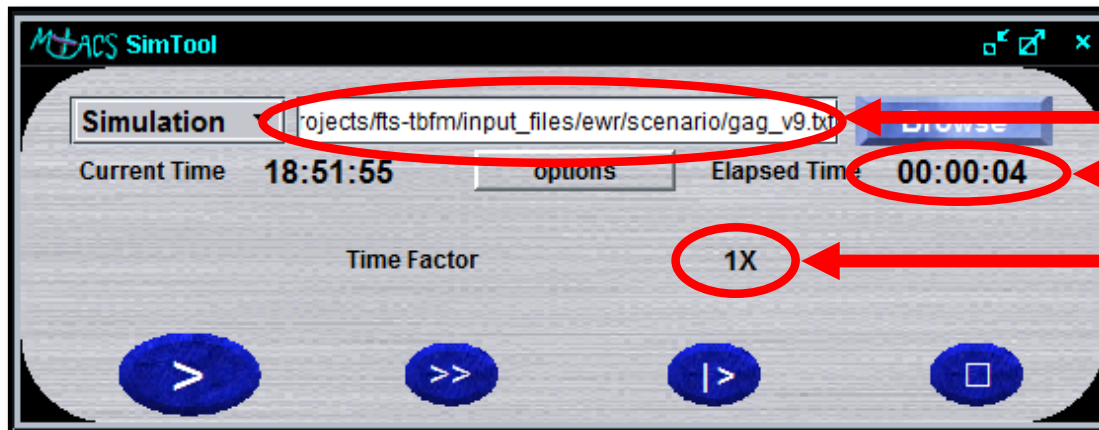
```
11:27:17 AM RESPONSE,314416,HOOK,ATC_PREDEPARTURE_FREEZE—
ATC_UPLINK_RT—ATC_PTIME_CHANGE—
ATC_RELEASE_DEPARTURE—ATC_TIMELINE_ASSIGN_COMMAND—
ATC_STATE_METERFIX_CROSSED—ATC_STATE_RUNWAY_CROSSED—
ATC_STATE_STA_FROZEN—ATC_TIMELINE_STA_FROZEN—
ATC_TIMELINE_STA_UNFROZEN—
ATC_TIMELINE_STA_FROZEN_CHANGEDATC_TIMELINE_DONE—
ATC_TIMELINE_ACTION—ATC_TIMELINE_SWAP_COMMAND—ATC_ACCEPT_DOWNLINK_ROUTE,true
11:27:17 AM [CLIENT:7850] REQUEST,551660,START,40—F472S—F406W—F360N—F40WHOLE~~~~
11:27:17 AM RESPONSE,551660,START,40—F472S—F406W—F360N—F40WHOLE,Successful (MACS
data loop successfully started)
```

/143.232.130.242:52884 who

Automatically start the server when MACS starts

Communication window
Server Status: Registered Open

Start simulation



Scenario file name

Simulation time

Simulation time factor
(simulation speed)

Launch nCTOP

59

Waiting for MACS traffic to settle...

[Click here if you are not redirected...](#)

Calculate new departure times

MACS-AOL-2017-05-22-12:27 NYTBO 22|31 Developer-Lite: guest Pilot-Config: view(Enabled) ATC-Sector: ZDC_12(Enabled) ADRS: offline 195 flights

18:28:18

GENERAL WINDOWS ATC/DST AIRCRAFT TOOLS SIM TOOL

MACS SimTool

nCTOP v1.30.n (Full control) [Open Connected] [/143.232.130.242:52890] (Sending Actual...)

Model: CTOP-ALL TOS

Parameters

Name: CTOP002 NASA1 Start: 07 1700 End: 07 2159

Rank 1 Automatic Revision (AR): Look-Ahead: 3 hrs AR Start: Offset: 1 hr Refresh Interval: 30 min Smoothing Factor: 45 min

Total Flights: ----- On Off

FEA/FCAs:

Exemptions:

Exempt all flights departing within 30 minutes. Pop-Up Delay Limit (minutes): 180

FCA Parameters

View: F472S Model Time: -- -- --

| Time: | 1815 | 1830 | 1845 | 1900 | 1915 | 1930 | 1945 | 2000 | 2015 | 2030 |
|-----------|------|------|------|------|------|------|------|------|------|------|
| Demand: | 0 | 2 | 4 | 5 | 6 | 2 | 3 | 1 | 4 | 4 |
| Capacity: | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| AR_Above: | | | | | | | | | | |
| AR_Below: | | | | | | | | | | |

Fill: Capacity With: From: 1815 Through: 1815

FEA/FCA: Start: End: Ceiling: 600 Floor: 0

Bar Chart

F472S Hours Visible: 5 15 30 60 Capacity AR Merge flows

Demand

Flight List

F472S (52)

| # | FCA | ACID | ETA | BETD | CTD | G... | A... | BETA | STA | Current RTE | ORIG | I |
|----|----------|---------|---------|---------|---------|------|------|---------|---------|----------------------------|------|---|
| 01 | F472S... | JBU416 | 04/2015 | 04/1926 | 04/1926 | 0 | 0 | 04/2017 | 04/2015 | KMCO/.OPMAY..ILM..FA... | KMCO | Z |
| 02 | F472S... | UAL237 | 04/1846 | 04/1844 | 04/1844 | 0 | 0 | 04/1846 | 04/1846 | KMYR./.FAK.PHLB03..KEWR | KMYR | Z |
| 03 | F472S... | ASQ4152 | 04/1951 | 04/1942 | 04/1942 | 0 | 0 | 04/1952 | 04/1951 | KGSP./.SPA..GENOD..GS... | KGSP | Z |
| 04 | F472S... | ASQ4394 | 04/2219 | 04/2140 | 04/2140 | 0 | 0 | 04/2221 | 04/2219 | KJAX./.CAE.J51..FAK..PH... | KJAX | Z |
| 05 | F472S... | UAL1238 | 04/2151 | 04/2044 | 04/2044 | 0 | 0 | 04/2152 | 04/2154 | KRSW./.PAILS..FAK..PHL... | KRSW | Z |
| 06 | F472S... | JBU428 | 04/1921 | 04/1832 | 04/1832 | 0 | 0 | 04/1923 | 04/1921 | KMCO/.OPMAY..ILM..FA... | KMCO | Z |

Filter: From: Through: Avg: 44 (165 nZ) Median: 0.0 Mode: 0 (38) Range: 754 (0-754)

Show Current Route Show Assigned Route

Model TOS Algorithm

ASSIGN SWAP RESET

ASSIGN SWAP RESET

FP ETA F472S STA F472S FP ETA F300W STA F300W

1872507064;VRD166
89~15018739372
000;UAL1289~150
50187754110;UAL
AAL5633~15018789
9814225;FDX3022~
~1501880540380;U
UAL575~150188201
3100000;ASQ4956
1280~150188430000

252110;ASQ4301~1
1501875986976;BA
LH654~1501879065
;ASQ4191~150188
4887176;ASQ4747

ZBW-1
ZNY-1

11:28 AM
8/4/2017

Run simulation

The screenshot displays the MACS (Mission Area Control System) interface. At the top, a status bar shows system information: MACS-AOL-2017-05-22-12:27, NYTBO 22|31, Developer-Lite: guest, Pilot-Config: view(Enabled), ATC-Sector: ZDC_12(Enabled), ADRS: offline, and 195 flights. The main interface is divided into three primary windows:

- Traffic display screen:** A large map window titled "MACS ERAM_VIEW -- Configuration: Center" showing a detailed traffic display. It features a toolbar at the top left with the number "1829 12" and a "TOOLBAR" label. The map displays numerous aircraft icons with callouts such as "UAL 1632", "FDX3022", "VRD1178", "AAL1492", and "ASQ439". A red text label "Traffic display screen" is overlaid on the map. A context menu is visible at the bottom right of the map with options: "ACCEPT", "TOGGLE ALL TIMELINES", and "TL".
- Communication window:** A window titled "MACS External Communications [Server (/143.232.130.242:7850)]". It shows server IP: 143.232.130.242, Port: 7850, and a "Stop" button. The status is "Server Status: Registered Open". A log entry reads: "11:28:58 AM RESPONSE,705279,START,180-F472S-F406W-F360N-F40WHOLE,Successful (MACS Periodic Loop already running)". A dropdown menu shows "/143.232.130.242:52884" and a "who" button. An option "Automatically start the server when MACS starts" is present and unchecked. A red text label "Communication window" is overlaid on the window.
- Simulation setup window:** A window titled "MACS SimTool" with a "Simulation" dropdown menu. The selected scenario is "objects/rs-tbfm/input_files/ewr/scenario/gag_v9.bt". It displays "Current Time 18:29:12" and "Elapsed Time 00:01:59". The "Time Factor" is set to "1X". At the bottom, there are four control buttons: a play button (>), a fast forward button (>>), a stop button (|), and a refresh button (↻). A red text label "Simulation setup window" is overlaid on the window.

Monitor simulation status

```
Run FTS-Macs-batch
waypoint SSC345020 specified more than once:
  previous SSC345020,,34.2502777778,-80.6663888889,0.0,0.0,0.0,729.133177634,305.922805499,790.711043082,0.397262877815,0.0,0.0,0.0,original,None
  new SSC345020,,34.2502777778,-80.6663888889,0.0,0.0,0.0,729.133177634,305.922805499,790.711043082,0.397262877815,0.0,0.0,0.0,original,None
waypoint ZORBO specified more than once:
  previous ZORBO,,41.6572222222,-79.2075,0.0,0.0,0.0,730.322076911,763.42859306,1056.50061653,0.807557883635,0.0,0.0,0.0,original,None
  new ZORBO,,41.6572222222,-79.2075,0.0,0.0,0.0,730.322076911,763.42859306,1056.50061653,0.807557883635,0.0,0.0,0.0,original,None
waypoint # specified more than once:
  previous #,,0.0,0.0,0.0,0.0,0.0,7443.20256093,347.794210912,7451.32371973,0.046692457896,0.0,0.0,0.0,original,None
  new #,,0.0,0.0,0.0,0.0,0.0,7443.20256093,347.794210912,7451.32371973,0.046692457896,0.0,0.0,0.0,original,None
MF_MIT
{}
start: 2017-08-04 11:51:17
proc1 C:/Users/jli10/PycharmProjects/fts-tbfm/input_files/EWR/Scenario/GAG_
C:/Users/jli10/PycharmProjects/fts-tbfm/input_files/EWR/Scenario/GAG_v9.txt
proc2 C:/Users/jli10/PycharmProjects/fts-tbfm/input_files/EWR/Scenario/MACS
C:/Users/jli10/PycharmProjects/fts-tbfm/input_files/EWR/Scenario/MACS_20170

proc1 - C:/Users/jli10/PycharmProjects/fts-tbfm/input_files/EWR/Scenario/
'C:/FastTimeSim/NYTBO/macs.bat' is not recognized as an internal or extern
operable program or batch file.
Received a flight data.....
Received a flight data.....
Processing the flight data....

The flight data is processed....

08-04-2017_11-52-02.17
Received a flight data.....
Processing the flight data....

stop
Re-schedule internal departure ASQ4672...
Re-schedule internal departure RPA3142...
The flight data is processed....

Received a flight data.....
Received a flight data.....
Processing the flight data....

The flight data is processed....
```

08-04-2017_11-52-02.17

Received a flight data.....

Processing the flight data....

stop

Re-schedule internal departure ASQ4672...

Re-schedule internal departure RPA3142...

The flight data is processed....

Received a flight data.....

Received a flight data.....

Processing the flight data....

The flight data is processed....

Batch process terminated

```
ftstbfrm - [C:\Users\j1110\PycharmProjects\fts-tbfrm] - ...FTS.bat.txt - PyCharm Community Edition 2017.1.3
File Edit View Navigate Code Refactor Run Tools VCS Window Help
fts-tbfrm | FTS.bat.txt | FTS-Macs-batch.py | FTSClasy.py | ORC_TBFMScheduling.py | process_TBFMEtdAntlns_v2.py | GAG_V9.bat
Project
fts-tbfrm C:\Users\j1110\PycharmProjects\fts-tbfrm
input_files
output_files
schedule
TBFMSettings
config.py
FTS-Macs-batch.py
FTS.bat.txt
FTSClasy.py
ORC_TBFMScheduling.py
ORC_TBFMScheduling.py
process_TBFMEtdAntlns_v2.py
Run
FTS-Macs-batch
()
start: 2017-08-04 11:59:24
proc1 C:/Users/j1110/PycharmProjects/fts-tbfrm/input_files/EWR/Scenario/GAG_v9.txt 1x 5 10
C:/Users/j1110/PycharmProjects/fts-tbfrm/input_files/EWR/Scenario/GAG_v9.txt 1x 5 10
proc1 - C:/Users/j1110/PycharmProjects/fts-tbfrm/input_files/EWR/Scenario/GAG_v9.txt 1x 5 10
Received a flight data.....
Processing the flight data....
The flight data is processed....
08-04-2017 12-00-09.06
Received a flight data.....
Processing the flight data....
stop
Re-schedule internal departure S04672...
Re-schedule internal departure RPAS142...
The flight data is processed....
Received a flight data.....
Processing the flight data....
The flight data is processed....
Received a flight data.....
Processing the flight data....
Re-schedule internal departure DAL1340...
The flight data is processed....
Received a flight data.....
Processing the flight data....
The flight data is processed....
Waiting for finishing the last data.2017-08-04 12:05:01.056000
```

Received a flight data.....
Processing the flight data....

The flight data is processed....

Waiting for finishing the last data.2017-08-04 12:05:01.056000

STARS ATM VIEW ADMIN ERAM

fts-tbfrm/input_files/ewr/s/enario/gag_v9.txt Browse

05 options Elapsed Time 00:00:00

Time Factor 1X

>> > <

MACS External Communications [Server (/143.232.130.242:7850)]

Server IP: 143.232.130.242 Port: 7850

Stop Server Status: Registered Open

143.232.130.242:53043 who

Automatically start the server when MACS starts



Log data

| Name | Date modified | Type | Size |
|---|-------------------|----------------------|----------|
| RUNLOG | 8/4/2017 12:06 PM | Text Document | 220 KB |
| flightSchedule_mytest_2017-08-04_12-06... | 8/4/2017 12:06 PM | Microsoft Excel C... | 1 KB |
| nodeSchedule_mytest_2017-08-04_12-06... | 8/4/2017 12:06 PM | Microsoft Excel C... | 1 KB |
| FTS_proc1_2017-08-04_11-59-25 | 8/4/2017 11:59 AM | Text Document | 0 KB |
| FTS_proc1_flightData_2017-08-04_11-59-25 | 8/4/2017 11:59 AM | Text Document | 0 KB |
| FTS_proc1_raw_2017-08-04_11-59-25 | 8/4/2017 11:59 AM | Text Document | 0 KB |
| FTS_proc1_special_2017-08-04_11-59-25 | 8/4/2017 11:59 AM | Text Document | 0 KB |
| FTS_proc1_flightData_2017-08-04_11-51-18 | 8/4/2017 11:53 AM | Text Document | 330 KB |
| FTS_proc1_raw_2017-08-04_11-51-18 | 8/4/2017 11:53 AM | Text Document | 261 KB |
| FTS_proc1_special_2017-08-04_11-51-18 | 8/4/2017 11:53 AM | Text Document | 549 KB |
| FTS_proc1_2017-08-04_11-51-18 | 8/4/2017 11:51 AM | Text Document | 0 KB |
| FTS_proc1_flightData_2017-08-04_11-50-06 | 8/4/2017 11:51 AM | Text Document | 326 KB |
| FTS_proc1_raw_2017-08-04_11-50-06 | 8/4/2017 11:51 AM | Text Document | 341 KB |
| FTS_proc1_special_2017-08-04_11-50-06 | 8/4/2017 11:51 AM | Text Document | 548 KB |
| FTS_proc1_2017-08-04_11-50-06 | 8/4/2017 11:50 AM | Text Document | 0 KB |
| FTS_proc1_2017-08-04_11-33-12 | 8/4/2017 11:33 AM | Text Document | 0 KB |
| FTS_proc1_flightData_2017-08-04_11-33-12 | 8/4/2017 11:33 AM | Text Document | 0 KB |
| FTS_proc1_raw_2017-08-04_11-33-12 | 8/4/2017 11:33 AM | Text Document | 0 KB |
| FTS_proc1_special_2017-08-04_11-33-12 | 8/4/2017 11:33 AM | Text Document | 0 KB |
| FTS_proc1_flightData_2017-08-04_11-26-41 | 8/4/2017 11:29 AM | Text Document | 496 KB |
| FTS_proc1_raw_2017-08-04_11-26-41 | 8/4/2017 11:29 AM | Text Document | 349 KB |
| FTS_proc1_special_2017-08-04_11-26-41 | 8/4/2017 11:29 AM | Text Document | 332 KB |
| FTS_proc1_2017-08-04_11-26-41 | 8/4/2017 11:26 AM | Text Document | 0 KB |
| FTS_proc1_2017-08-04_11-26-33 | 8/4/2017 11:26 AM | Text Document | 0 KB |
| FTS_proc1_flightData_2017-08-04_11-26-33 | 8/4/2017 11:26 AM | Text Document | 0 KB |
| FTS_proc1_raw_2017-08-04_11-26-33 | 8/4/2017 11:26 AM | Text Document | 0 KB |
| FTS_proc1_special_2017-08-04_11-26-33 | 8/4/2017 11:26 AM | Text Document | 0 KB |
| FTS_proc1_2017-08-04_11-26-17 | 8/4/2017 11:26 AM | Text Document | 0 KB |
| FTS_proc1_flightData_2017-08-04_11-26-17 | 8/4/2017 11:26 AM | Text Document | 0 KB |
| FTS_proc1_raw_2017-08-04_11-26-17 | 8/4/2017 11:26 AM | Text Document | 0 KB |
| FTS_proc1_special_2017-08-04_11-26-17 | 8/4/2017 11:26 AM | Text Document | 0 KB |
| flightSchedule_mytest_2017-08-04_11-23... | 8/4/2017 11:23 AM | Microsoft Excel C... | 1 KB |
| FTS_proc1_2017-08-02_11-04-07 | 8/4/2017 11:23 AM | Text Document | 2 KB |
| FTS_proc1_flightData_2017-08-02_11-04-07 | 8/4/2017 11:23 AM | Text Document | 1,184 KB |
| FTS_proc1_raw_2017-08-02_11-04-07 | 8/4/2017 11:23 AM | Text Document | 709 KB |
| FTS_proc1_special_2017-08-02_11-04-07 | 8/4/2017 11:23 AM | Text Document | 2,104 KB |
| nodeSchedule_mytest_2017-08-04_11-23... | 8/4/2017 11:23 AM | Microsoft Excel C... | 1 KB |
| FTS_proc1_flightData_2017-08-02_10-57-17 | 8/4/2017 11:23 AM | Text Document | 163 KB |
| FTS_proc1_raw_2017-08-02_10-57-17 | 8/4/2017 11:23 AM | Text Document | 173 KB |
| FTS_proc1_special_2017-08-02_10-57-17 | 8/4/2017 11:23 AM | Text Document | 268 KB |
| FTS_proc1_2017-08-04_10-37-07 | 8/4/2017 11:09 AM | Text Document | 3 KB |
| FTS_proc1_flightData_2017-08-04_10-37-07 | 8/4/2017 11:09 AM | Text Document | 2,037 KB |
| FTS_proc1_raw_2017-08-04_10-37-07 | 8/4/2017 11:09 AM | Text Document | 1,158 KB |
| FTS_proc1_special_2017-08-04_10-37-07 | 8/4/2017 11:09 AM | Text Document | 3,908 KB |
| flightSchedule_mytest_2017-08-04_11-08... | 8/4/2017 11:08 AM | Microsoft Excel C... | 3 KB |
| nodeSchedule_mytest_2017-08-04_11-08... | 8/4/2017 11:08 AM | Microsoft Excel C... | 2 KB |
| FTS_proc1_flightData_2017-08-04_10-34-52 | 8/4/2017 10:36 AM | Text Document | 163 KB |
| FTS_proc1_raw_2017-08-04_10-34-52 | 8/4/2017 10:36 AM | Text Document | 173 KB |
| FTS_proc1_special_2017-08-04_10-34-52 | 8/4/2017 10:36 AM | Text Document | 268 KB |

| Name |
|---|
| RUNLOG |
| flightSchedule_mytest_2017-08-04_12-06... |
| nodeSchedule_mytest_2017-08-04_12-06... |
| FTS_proc1_2017-08-04_11-59-25 |
| FTS_proc1_flightData_2017-08-04_11-59-25 |
| FTS_proc1_raw_2017-08-04_11-59-25 |
| FTS_proc1_special_2017-08-04_11-59-25 |

Sample output

nodeSchedule_mytest_2017-08-04_20-55-20

Search Sheet

Home Insert Page Layout Formulas Data Review View

Calibri (Body) 12 A A

General

Conditional Formatting Format as Table Cell Styles

Insert Delete Format

AutoSum Fill Clear

Sort & Filter

A1 fx nodeId

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | reqT |
|----|--------|----------|----------|------------|------------|---------------|----------|------------|--------------|------------|------------|----------|--------------|------------|------|
| 1 | nodeId | nodeType | flightId | STA | ETA | delayPassback | NomSpeed | isInternal | eventTrigger | FH_CT | EDCT | depError | TBFMSchedDep | SchedDelay | reqT |
| 2 | EWR22L | RWY | UAL1116 | 1501892541 | 1501892541 | 0.00999999 | 140 | | | | | | | | |
| 3 | EWR22L | RWY | DAL1348 | 1501892732 | 1501892732 | 0.00999999 | 140 | TRUE | 1501888587 | | 1501888587 | -121 | 1501888587 | 0 | |
| 4 | EWR22L | RWY | JBU6 | 1501892948 | 1501892948 | 0.00999999 | 140 | FALSE | 1501888355 | 1501888355 | | | | | |
| 5 | EWR22L | RWY | BAW943 | 1501893134 | 1501893091 | 42.13638115 | 140 | FALSE | 1501889285 | 1501889285 | | | | | |
| 6 | EWR22L | RWY | SKV7007 | 1501893278 | 1501893095 | 182.1363811 | 140 | TRUE | 1501889751 | | 1501889751 | 95 | 1501889751 | 0 | |
| 7 | EWR22L | RWY | JBU328 | 1501893531 | 1501893531 | 0.00999999 | 140 | FALSE | 1501888867 | 1501888867 | | | | | |
| 8 | EWR22L | RWY | ASQ4672 | 1501893641 | 1501893551 | 89.45000005 | 140 | TRUE | 1501887764 | | 1501887764 | 102 | 1501887764 | 0 | |
| 9 | EWR22L | RWY | RPA3142 | 1501893733 | 1501893608 | 125.4344084 | 140 | TRUE | 1501888368 | | 1501888368 | -10 | 1501888368 | 0 | |
| 10 | EWR22L | RWY | ASQ4276 | 1501893826 | 1501893802 | 23.71285701 | 140 | TRUE | 1501889556 | | 1501889341 | 52 | 1501889556 | 215 | |
| 11 | EWR22L | RWY | TCF3792 | 1501894011 | 1501894003 | 8.17869401 | 140 | TRUE | 1501890505 | | 1501890505 | 50 | 1501890505 | 0 | |
| 12 | EWR22L | RWY | UCA4775 | 1501894104 | 1501893925 | 179.1628571 | 140 | TRUE | 1501891238 | | 1501890854 | 66 | 1501891238 | 384 | |
| 13 | EWR22L | RWY | VIR1F | 1501894204 | 1501894204 | 0.00999999 | 140 | FALSE | 1501890322 | 1501890322 | | | | | |
| 14 | EWR22L | RWY | SWA45 | 1501894415 | 1501894415 | 0.00999999 | 140 | FALSE | 1501889574 | 1501889574 | | | | | |
| 15 | EWR22L | RWY | AAL5177 | 1501894508 | 1501894244 | 264.2242858 | 140 | TRUE | 1501891891 | | 1501891834 | 200 | 1501891891 | 57 | |
| 16 | EWR22L | RWY | UAL1618 | 1501894778 | 1501894778 | 0.00999999 | 140 | FALSE | 1501890146 | 1501890146 | | | | | |
| 17 | EWR22L | RWY | UAL994 | 1501894871 | 1501894797 | 74 | 140 | TRUE | 1501891105 | | 1501891100 | -14 | 1501891105 | 5 | |
| 18 | EWR22L | RWY | ASQ4326 | 1501895058 | 1501895058 | 0.00999999 | 140 | TRUE | 1501889997 | | 1501889957 | 170 | 1501889997 | 40 | |
| 19 | EWR22L | RWY | UAL1419 | 1501895167 | 1501895089 | 77.92000008 | 140 | FALSE | 1501890411 | 1501890411 | | | | | |
| 20 | EWR22L | RWY | AAL2379 | 1501895334 | 1501895334 | 0.00999999 | 140 | FALSE | 1501888575 | 1501888575 | | | | | |
| 21 | EWR22L | RWY | VRD166 | 1501895451 | 1501895451 | 0.00999999 | 140 | FALSE | 1501889033 | 1501889033 | | | | | |
| 22 | EWR22L | RWY | BAW187 | 1501895544 | 1501895123 | 420.1519728 | 140 | FALSE | 1501891161 | 1501891161 | | | | | |
| 23 | EWR22L | RWY | ASQ5830 | 1501895688 | 1501895437 | 251.01 | 140 | TRUE | 1501892777 | | 1501892302 | -47 | 1501892777 | 475 | |
| 24 | EWR22L | RWY | JBU2579 | 1501895780 | 1501895598 | 182.5814285 | 140 | TRUE | 1501893102 | | 1501892579 | -30 | 1501893102 | 523 | |
| 25 | EWR22L | RWY | DLH26 | 1501895910 | 1501895910 | 0.00999999 | 140 | FALSE | 1501892057 | 1501892057 | | | | | |
| 26 | EWR22L | RWY | UAL1636 | 1501896095 | 1501896095 | 0.00999999 | 140 | FALSE | 1501891247 | 1501891247 | | | | | |
| 27 | EWR22L | RWY | UCA5884 | 1501896307 | 1501896307 | 0.00999999 | 140 | TRUE | 1501893976 | | 1501893563 | 179 | 1501893976 | 413 | |

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