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MATLAB&SIMULINK

Air Traffic Management using SimEvents®

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The MathWorks

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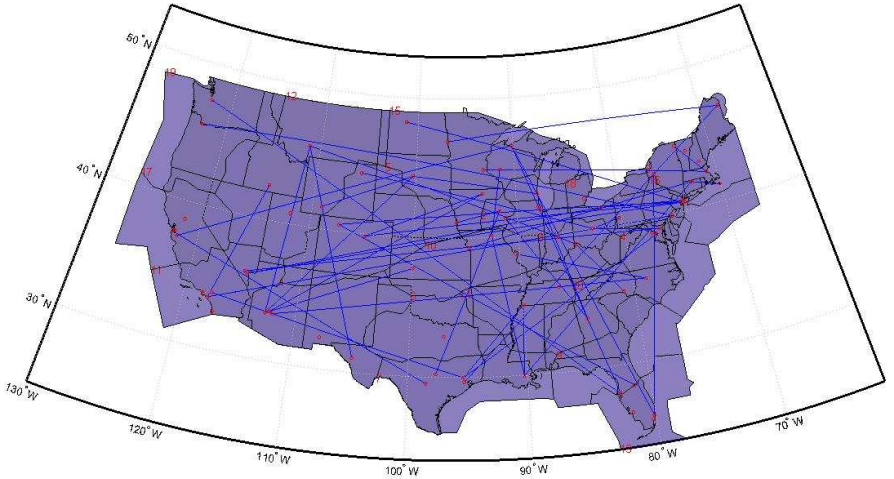
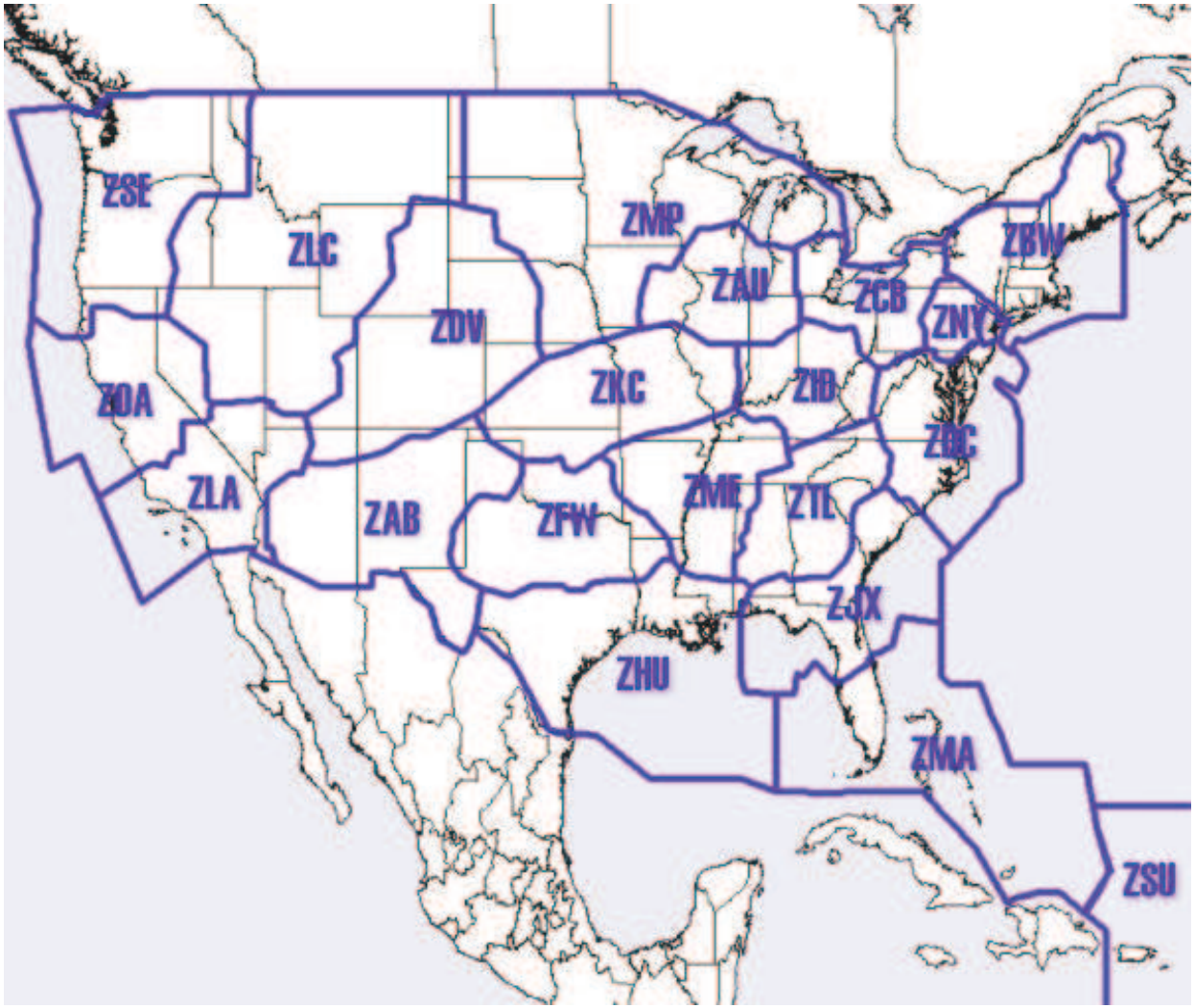
Outline

- Problem Background
- Discrete Event Simulation
- Modeling Approach



- Demo: Air Traffic Management with SimEvents
- Speeding up large-scale air traffic simulations

Problem Background



Modeling and Simulation Methodologies

Trajectory-Based Simulation

Used for:

- Trajectory Prediction
- Trajectory Optimization
- Conflict Detection/Resolution
- Weather Re-routing

Discrete Event Simulation

Used for:

- Traffic Flow Management
- Optimal Flight Scheduling
- Runway/Airspace Balancing
- Impact of Bad Weather

Discrete Event Simulation

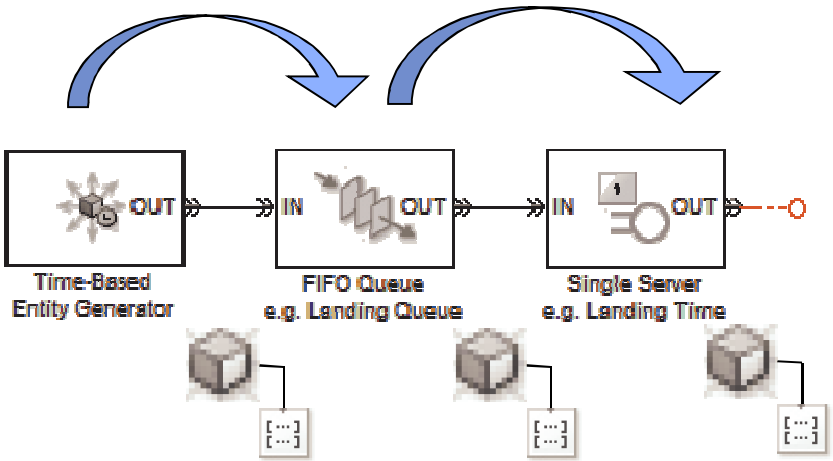
- Discrete-Event Simulation (DES) provides an efficient way to model event-based systems

- DES Simulations may be used to:
  - Model movement of entities
  - Capture queuing and transport delays

- SimEvents adds DES to Simulink®

- In This Demo
  - Entities = Airplane flight
  - Events = Landing / Take Off / Transition
  - Attributes = Qualities / Take Off Time / Airspeed

SimEvents Model



Workflow

- Flights
  - Path and Times
- Airports
  - # Runways
  - Runway Service Time
- Departures
  - Schedule

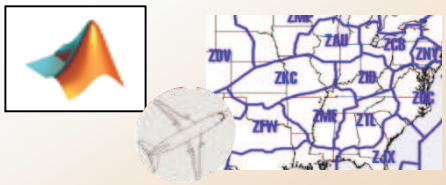
Build the Model

- Create SimEvents Model
  - Graphically (drag & drop)
  - Programmatically

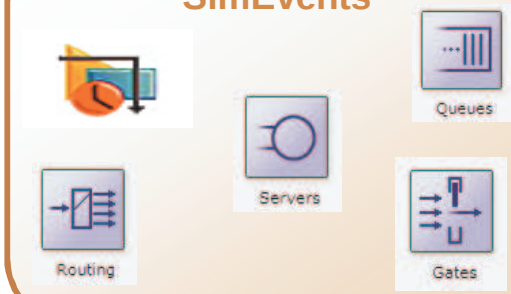
Save Files

- Inspect Network Performance
  - SimEvents Scopes
  - Save Data To MAT files
  - Process in MATLAB
  - Objective function for
  - Optimization

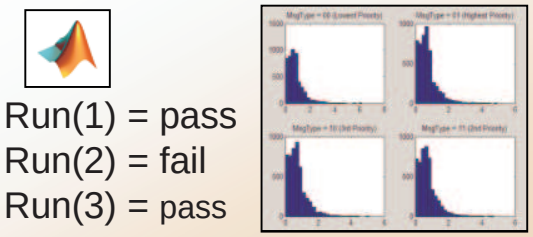
MATLAB Pre-Processing



SimEvents

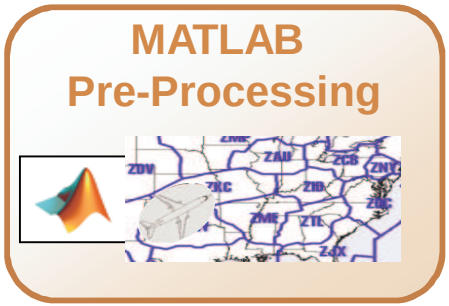


MATLAB Post-Processing

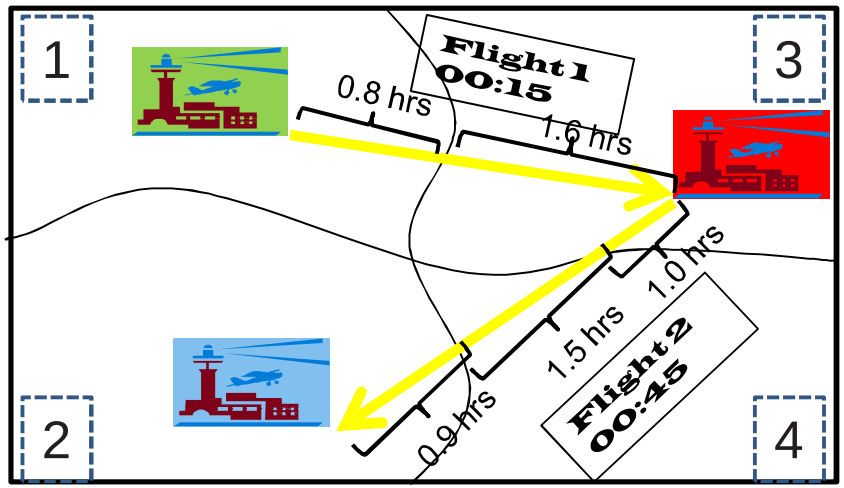


Run(1) = pass
Run(2) = fail
Run(3) = pass

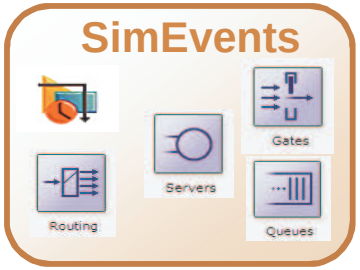
Pre-Processing in MATLAB

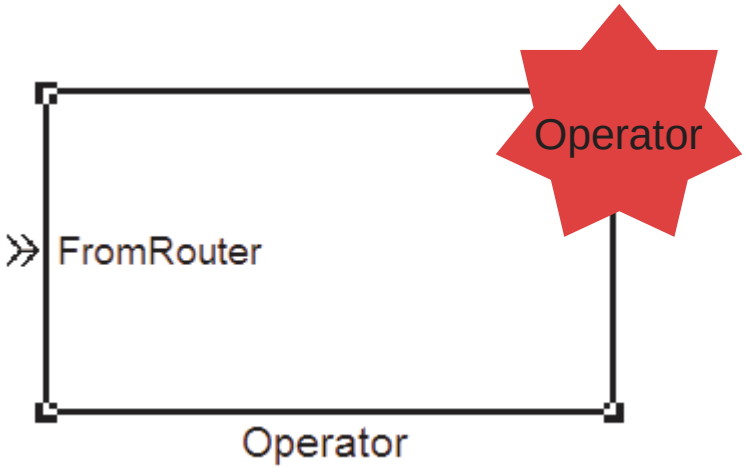


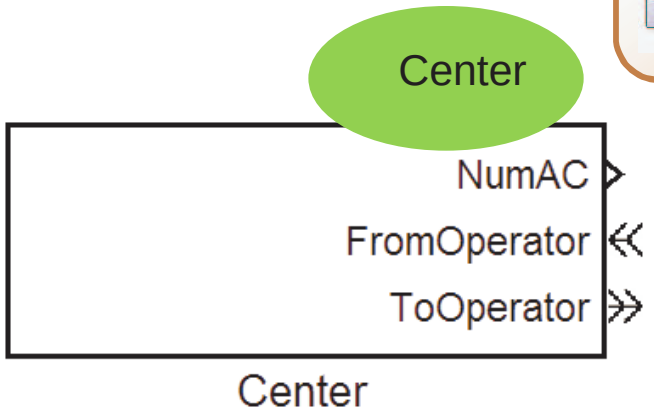
- Flights **Entity**
  - To / From airport **Attribute**
  - Departure time **Event**
  - Sequence through centers **Attribute**
  - Time spent in each center **Attribute**
- Airports
  - # Runways **Parameter**
  - Runway Service time **Parameter**
- Departures
  - List of entity (flights) generation times **Event**
- Centers
  - Capacity **Parameter**

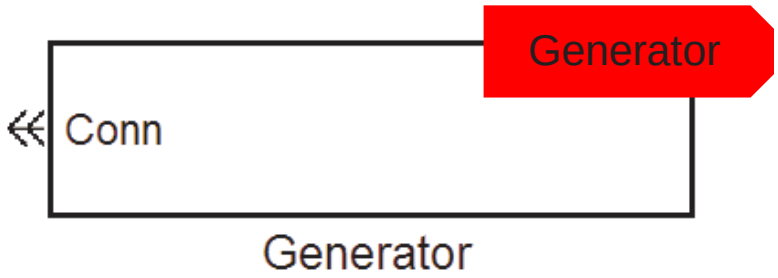


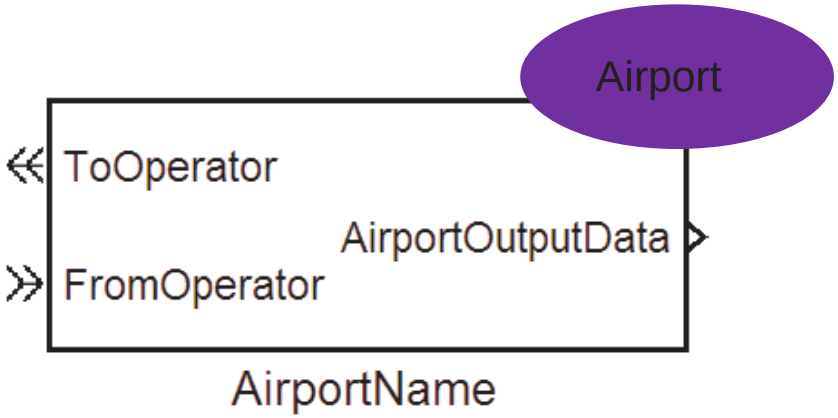
SimEvents Custom Library Blocks





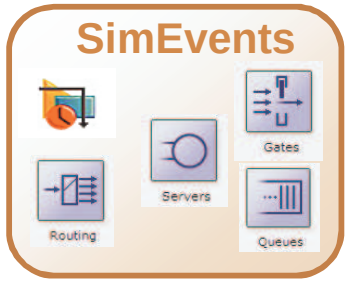






Star-Configured Modeling

(Operator Centric)



Processing Time
•Transition
•Weather Delay
•Queuing Delay

Center 1

Airport A

Processing Time
•Taxi
•Runways
•Climb Out

Operator

Center 2

Airport B

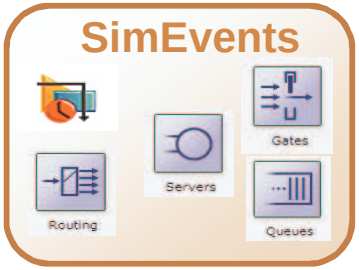
Processing Time
•Transition
•Weather Delay
•Queuing Delay

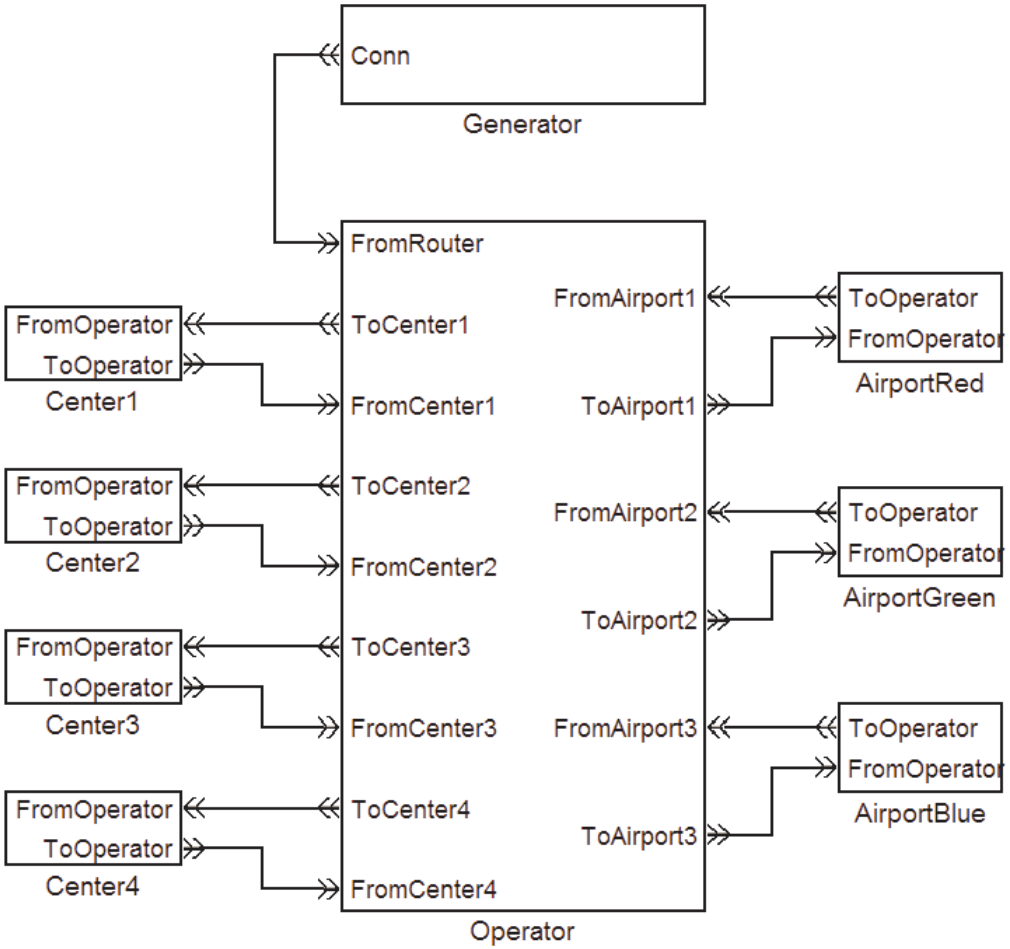
Center 3

Center 4

Processing Time
•Approach
•Descent
•Runways
•Taxi
•Etc…

Star-Configured Model

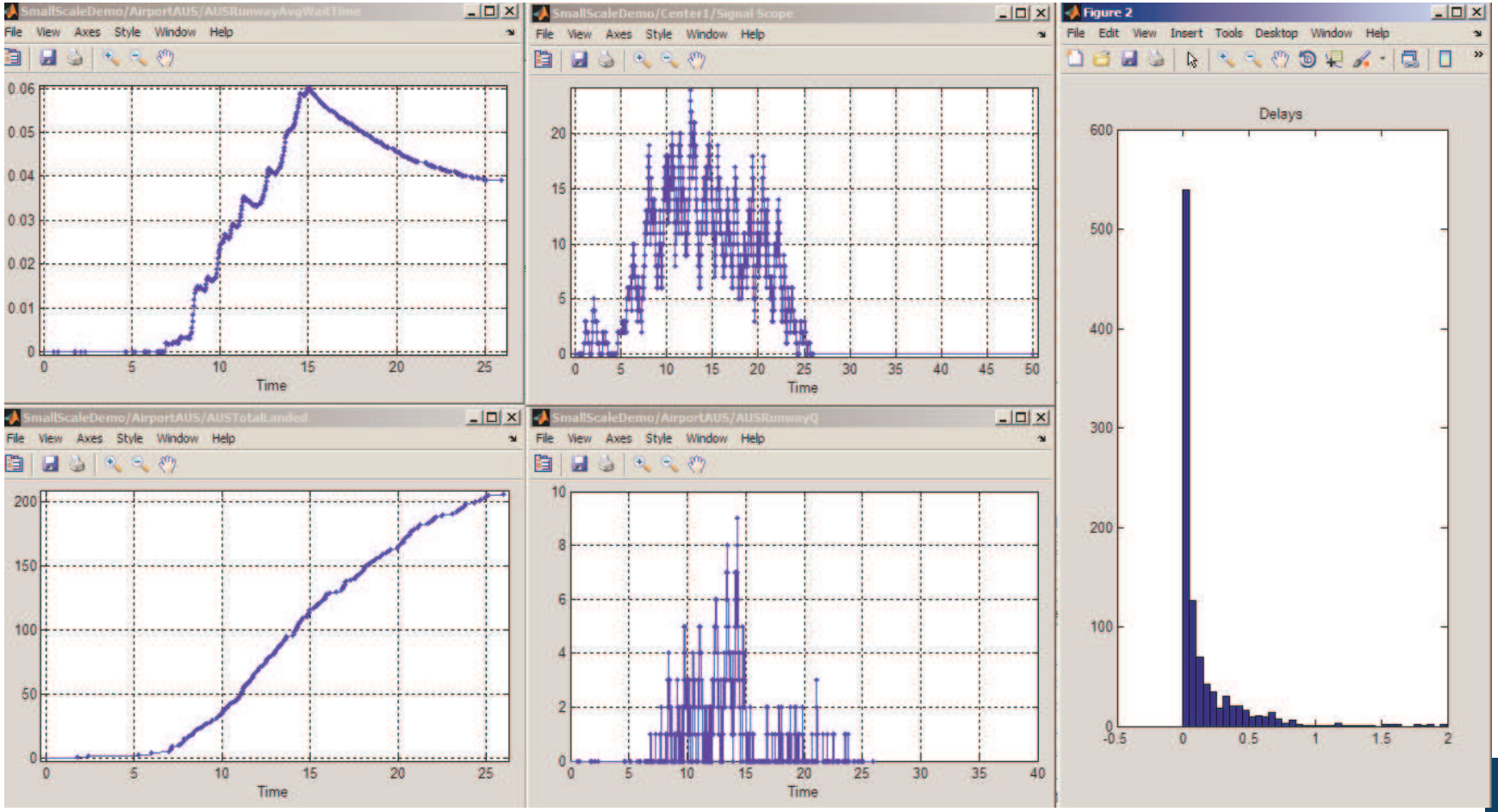




Sample Results

SimEvents Signal Scopes

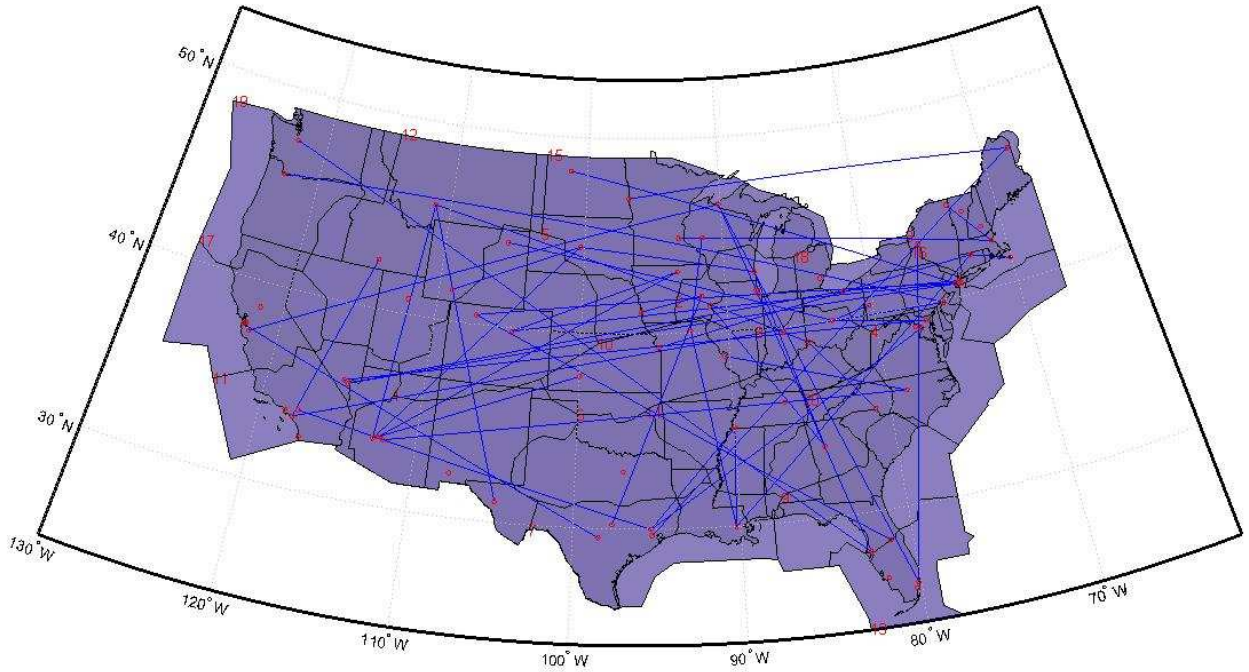
MATLAB
post-processing

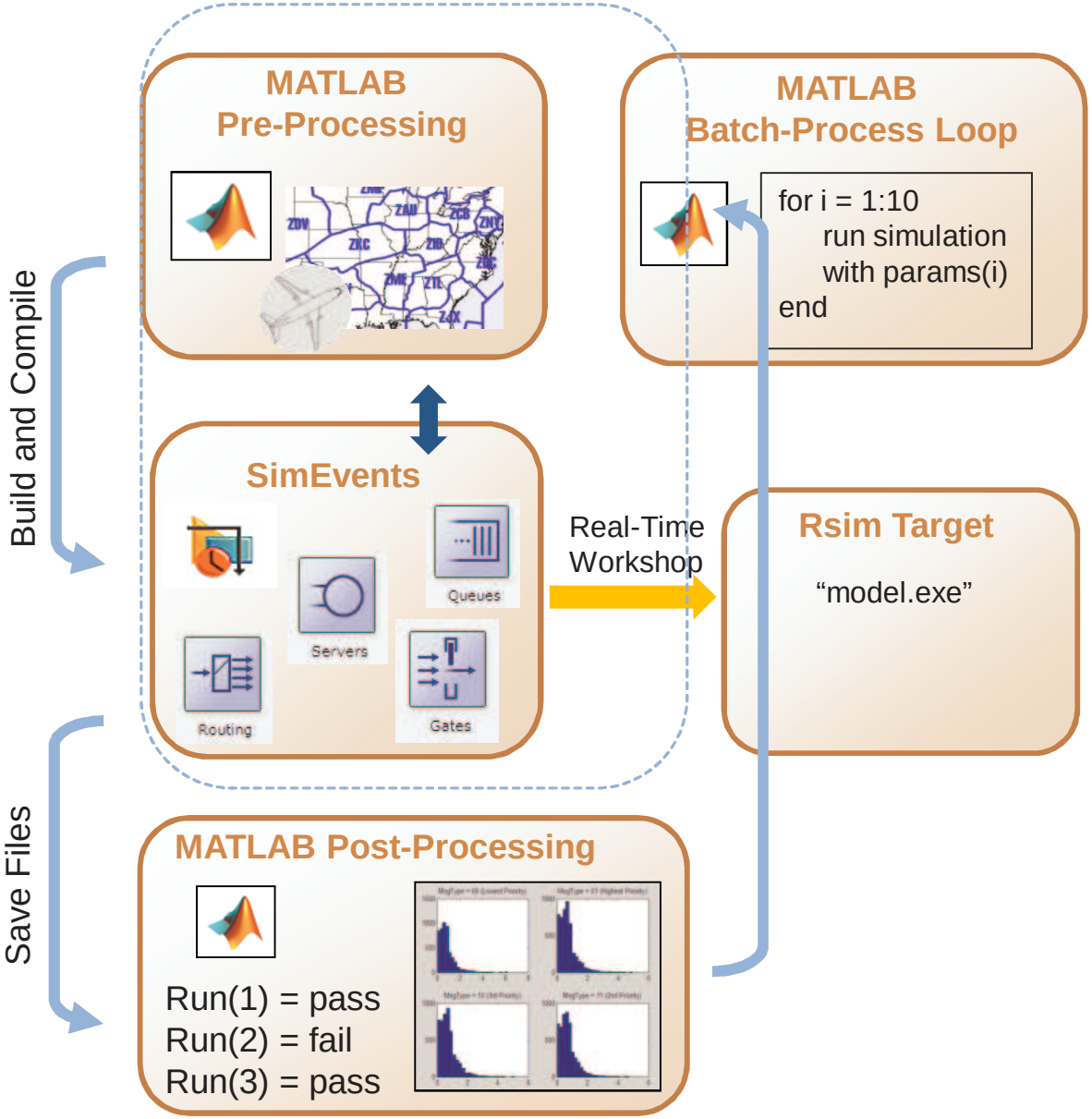


SimEvents Demo

Scaling Up and Simulation Speed

- Increase # Centers -> 20+
- Increase # Airports -> 200+
- Use real ARTCC structure
- Use real 48 state USA map
- Determine actual flight paths
- Build model programmatically




MATLAB
Pre-Processing
MATLAB
Batch-Process Loop
for i = 1:10
run simulation
with params(i)
end
Build and Compile
SimEvents
Queues
Servers
Routing
Gates
Real-Time
Workshop
Rsim Target
"model.exe"
Save Files
MATLAB Post-Processing
Run(1) = pass
Run(2) = fail
Run(3) = pass

What MathWorks can do for you:

- Share Demo Models
- Provide Consulting and Training Services
- Offer Evaluation Support

Contact your account manager or visit the SimEvents product website for more information:

http://www.mathworks.com/products/simevents/