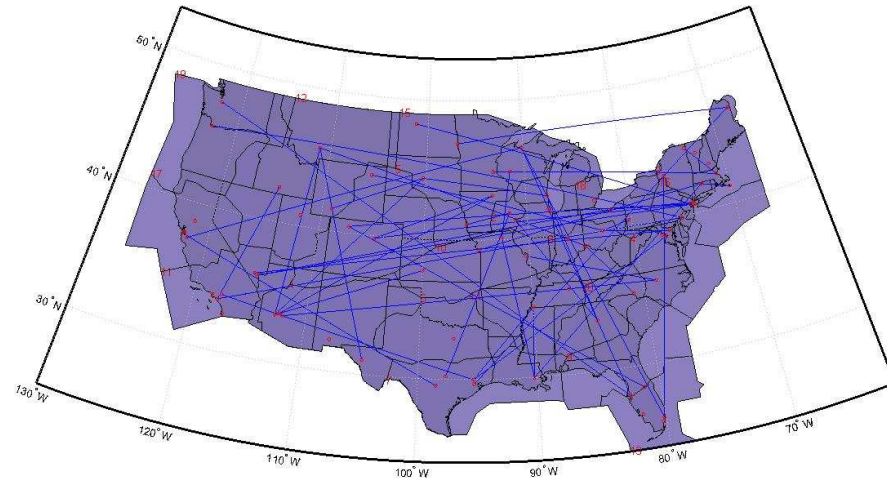


# Air Traffic Management using SimEvents®

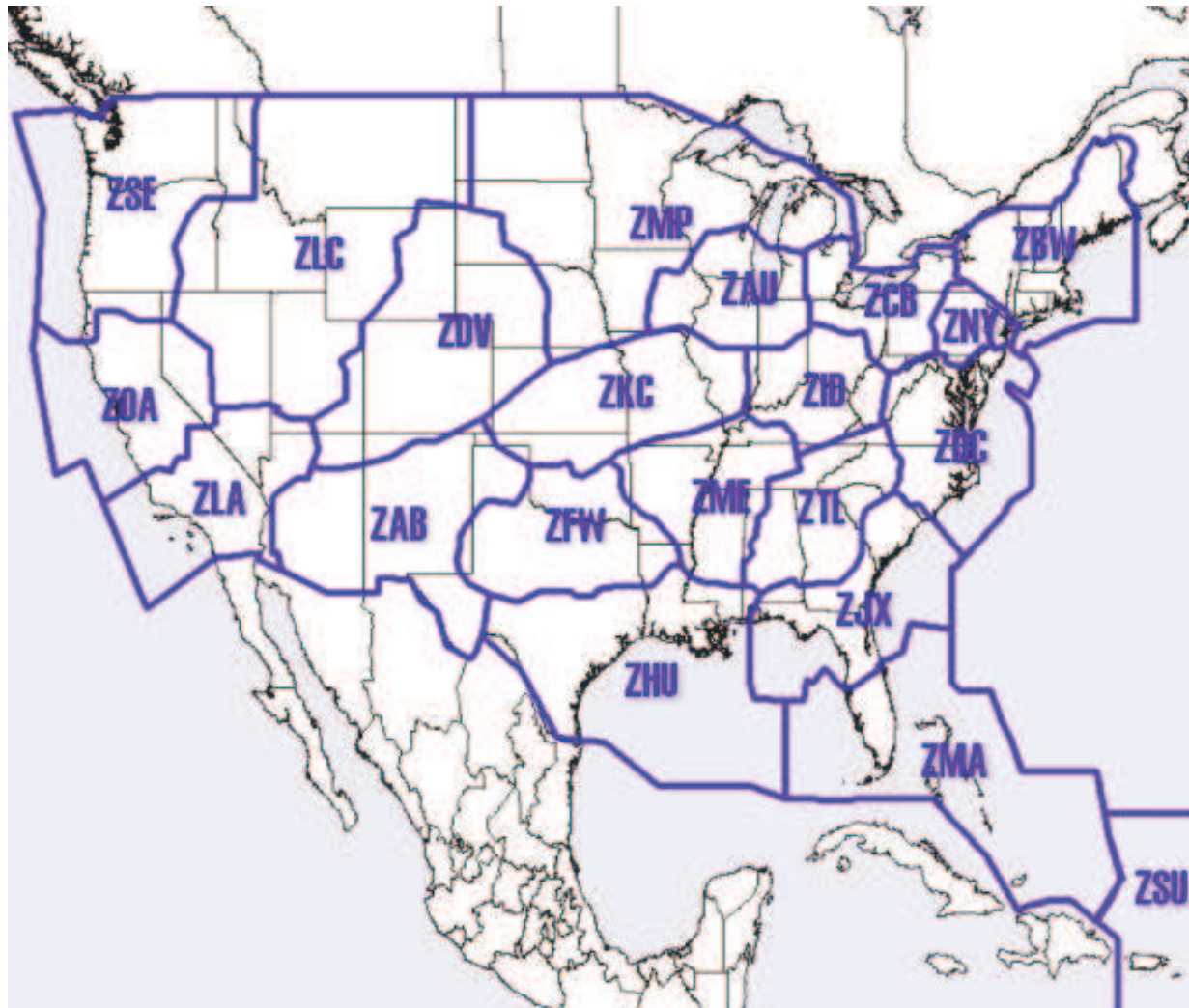
**Matt Jardin, David Manegold**  
The MathWorks

# 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®

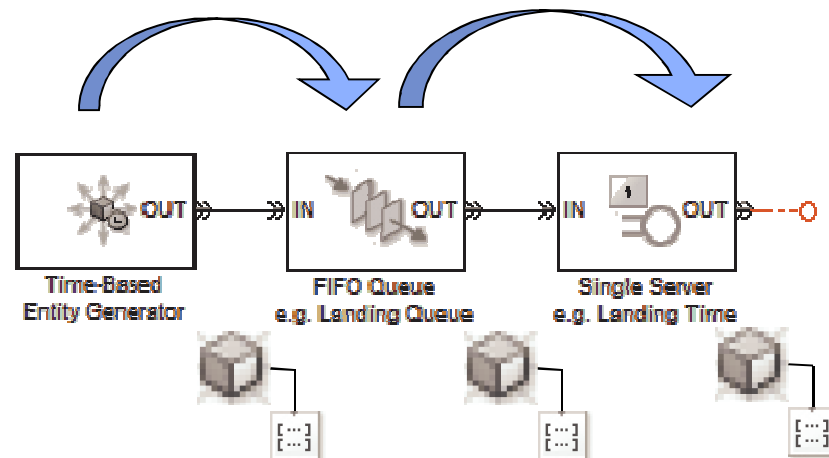
- In This Demo

 Entities = Airplane flight

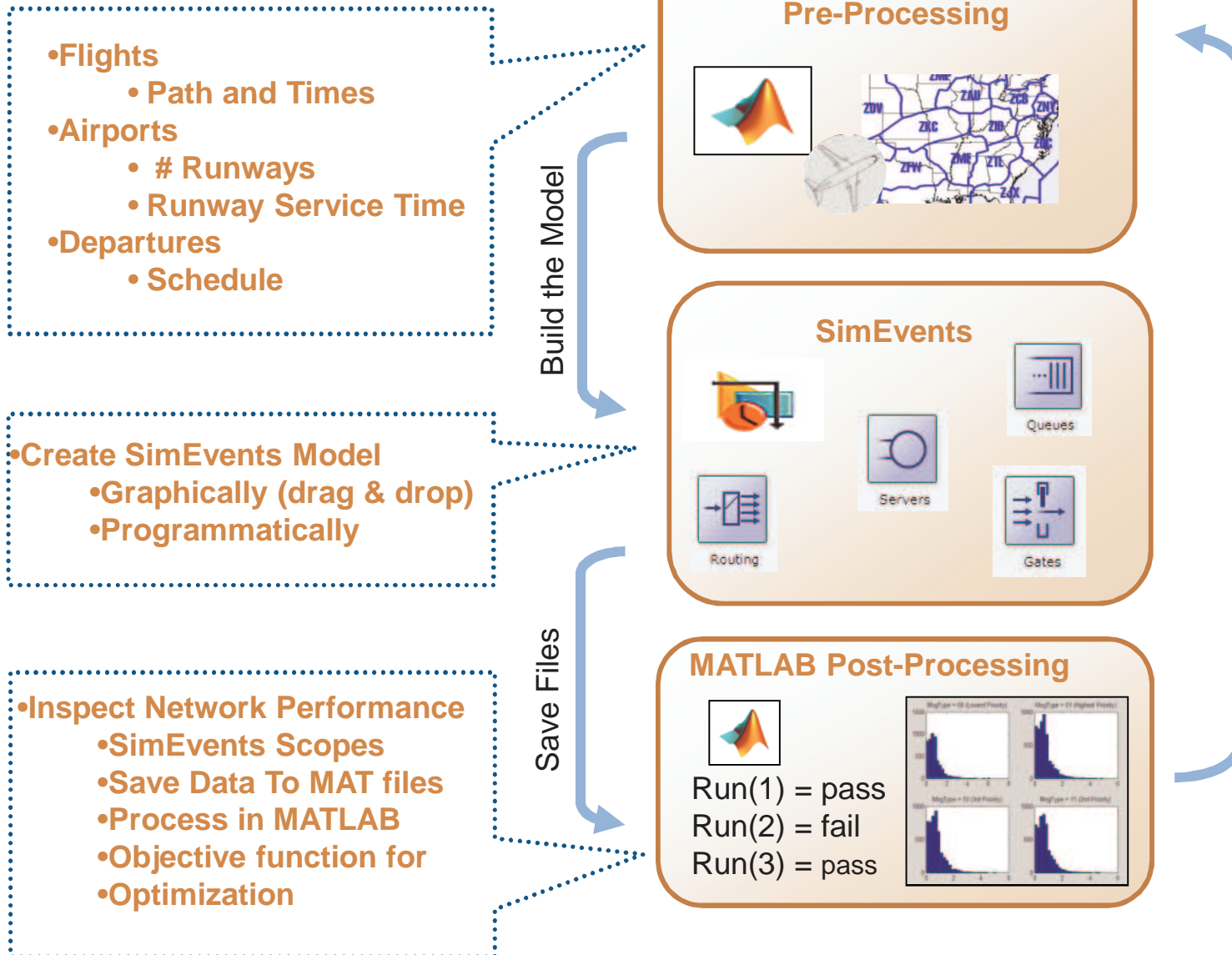
 Events = Landing / Take Off / Transition

 Attributes = Qualities / Take Off Time / Airspeed

## SimEvents Model

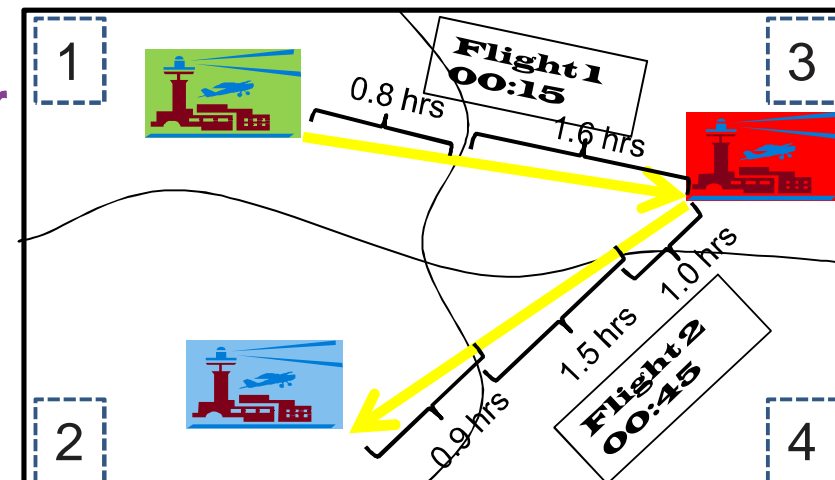
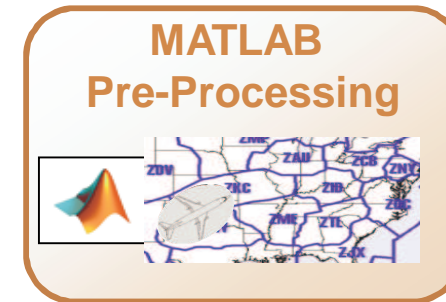


# Workflow



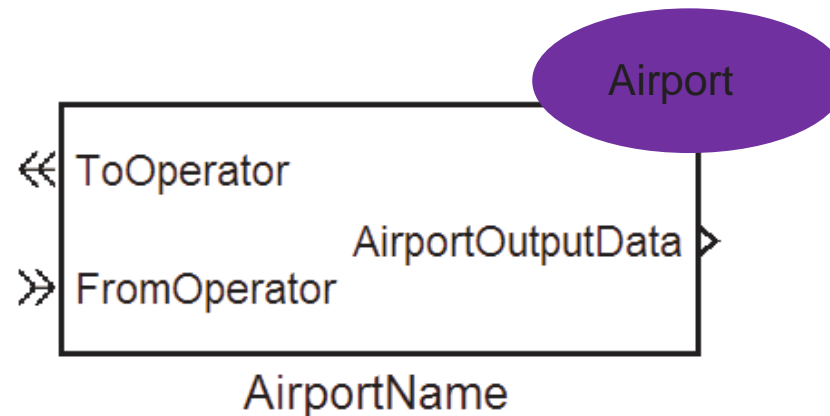
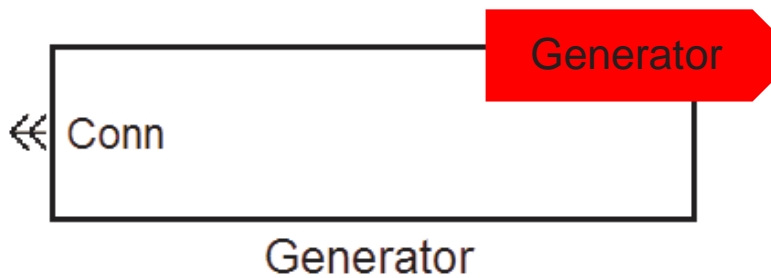
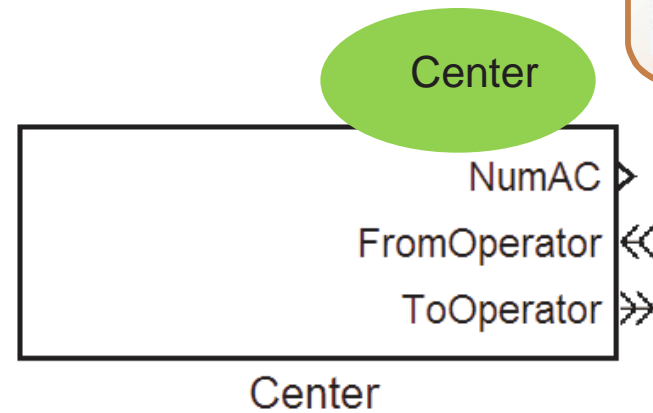
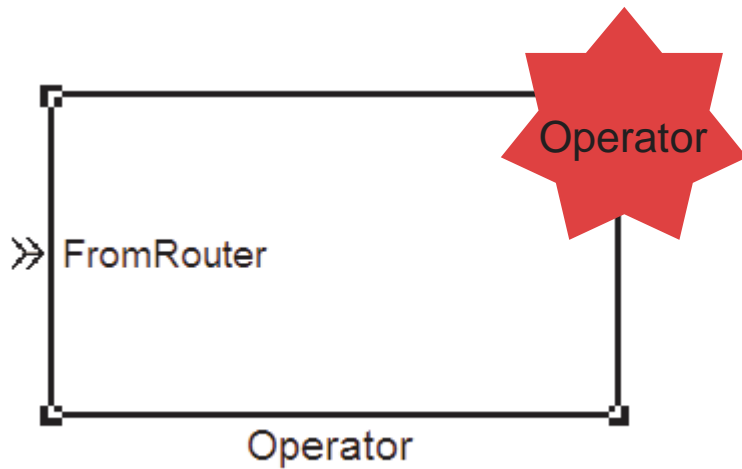
# Pre-Processing in MATLAB

- 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) **Event**  
generation times
- Centers
  - Capacity **Parameter**





# SimEvents Custom Library Blocks



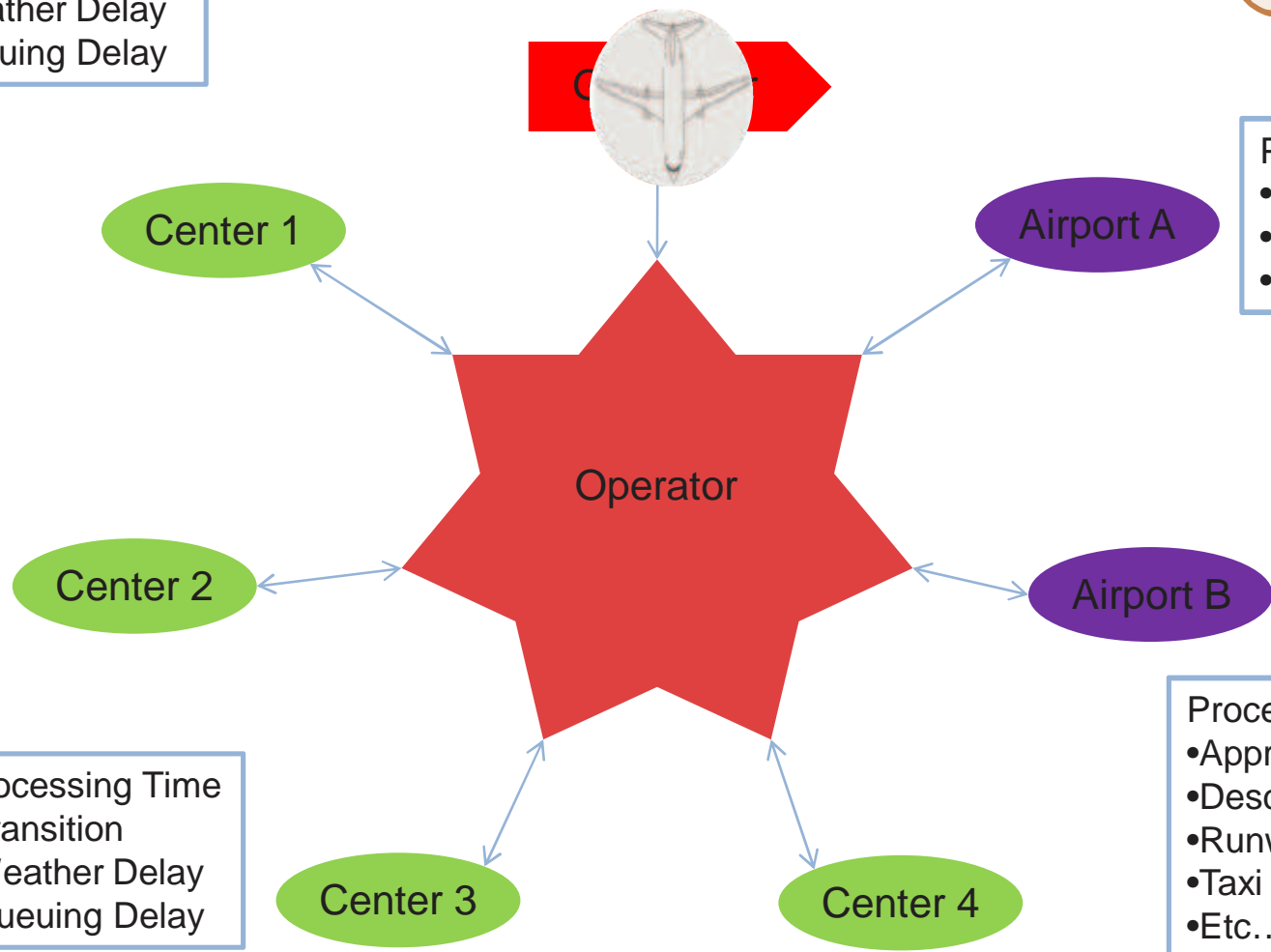


# Star-Configured Modeling (Operator Centric)

- Processing Time
- Transition
  - Weather Delay
  - Queuing Delay

**SimEvents**

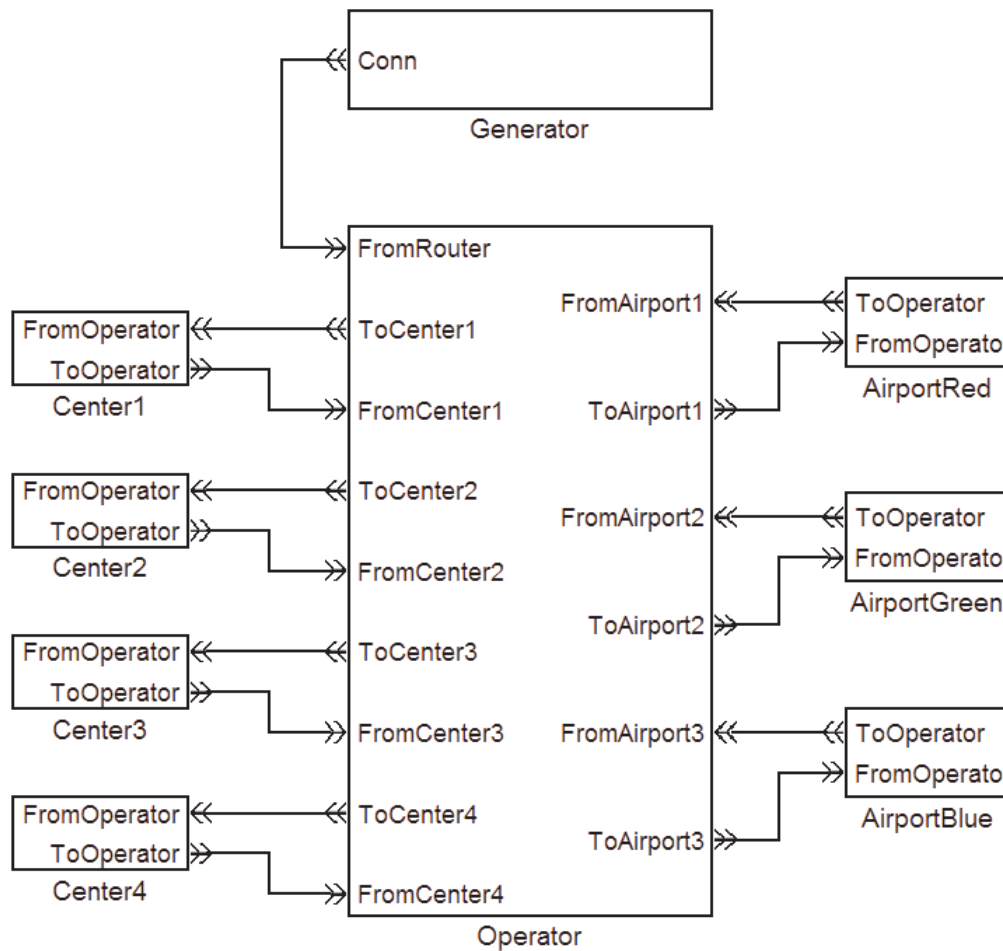
- Processing Time
- Taxi
  - Runways
  - Climb Out



- Processing Time
- Transition
  - Weather Delay
  - Queuing Delay

- Processing Time
- Approach
  - Descent
  - Runways
  - Taxi
  - Etc...

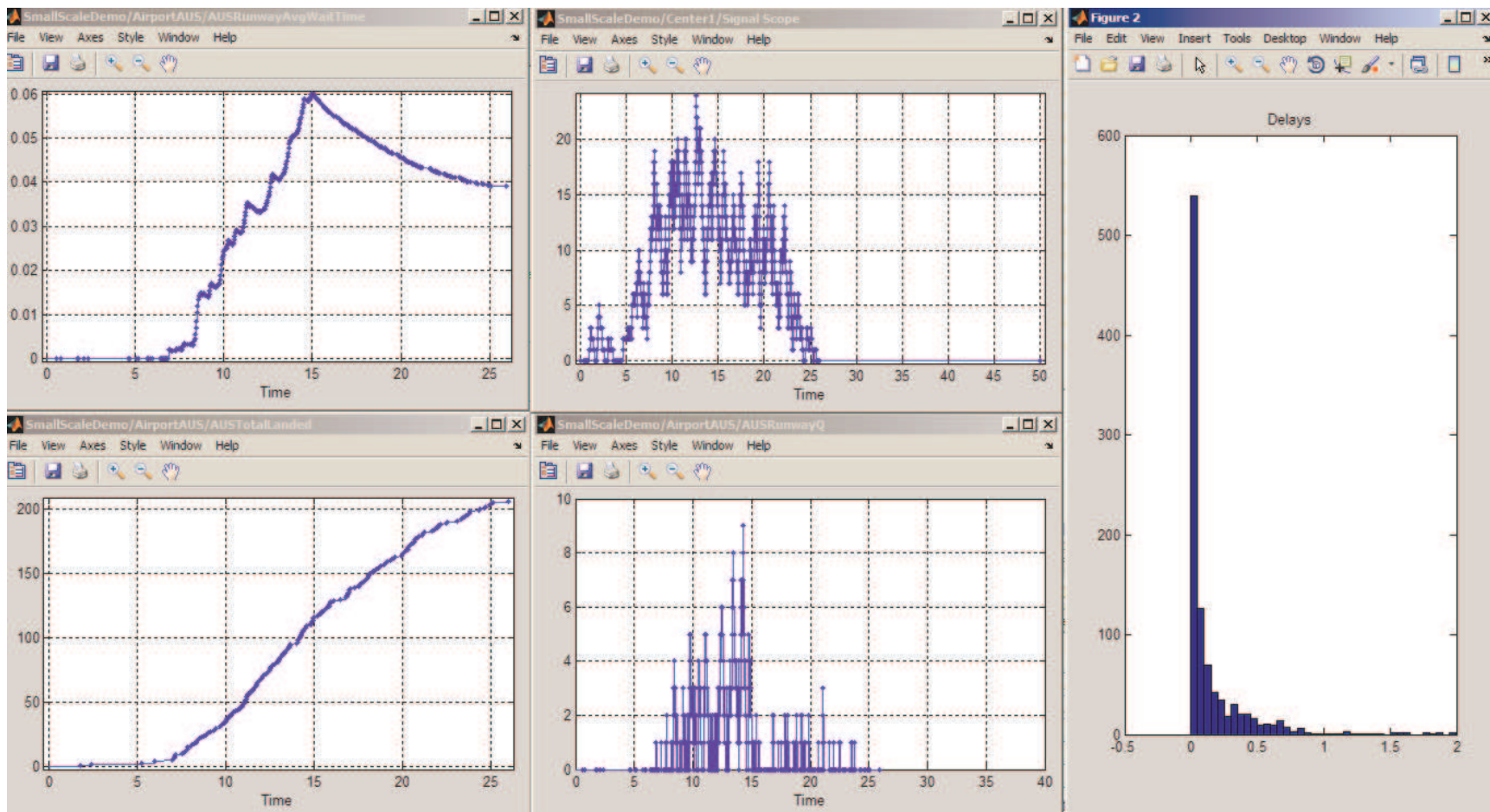
# Star-Configured Model



# Sample Results

SimEvents Signal Scopes

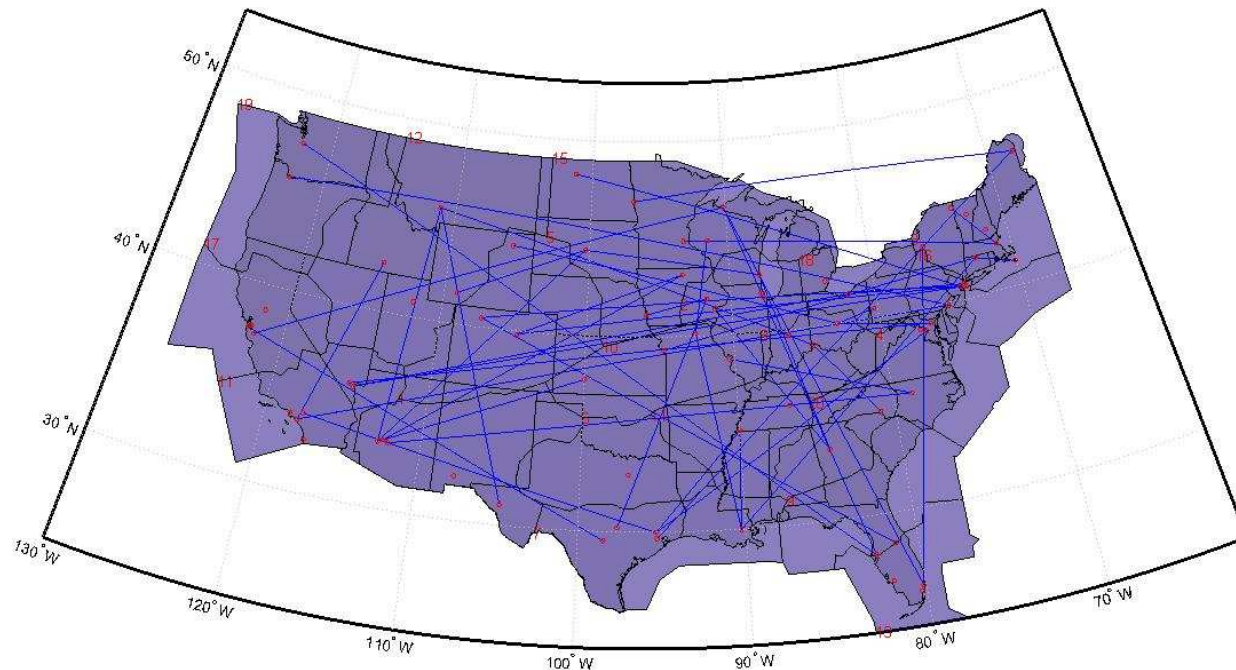
MATLAB  
post-processing

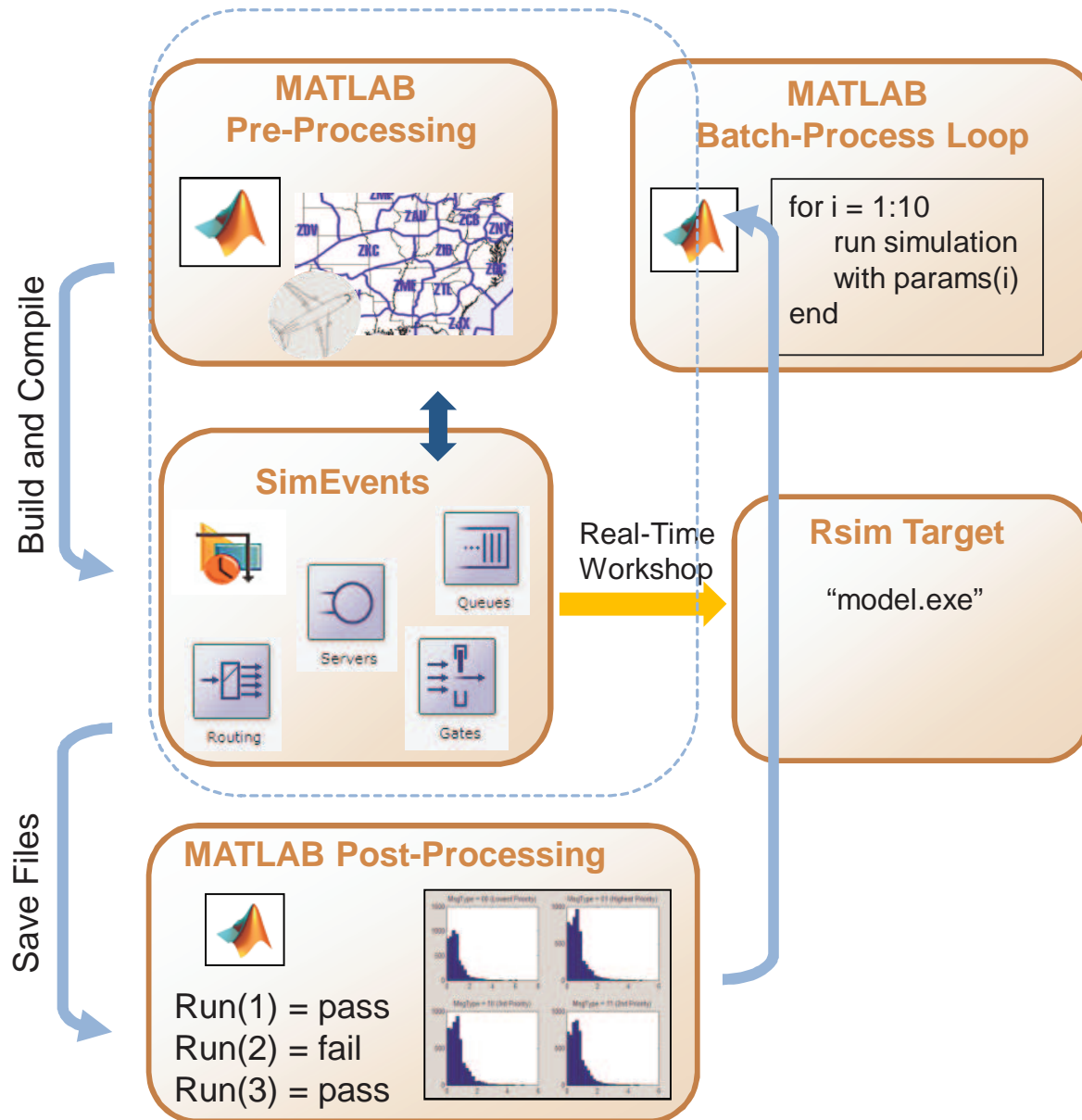


# SimEvents Demo

# 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







## 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/>