EDS/ETD Deployment Program:
Modeling and Simulation Approach

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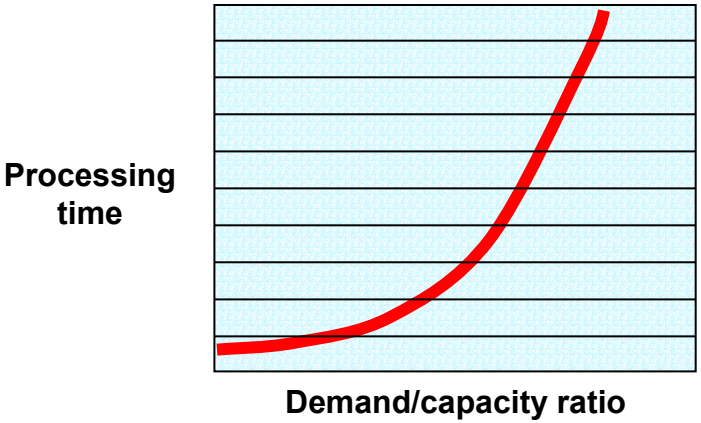
Role of Modeling and Simulation

- Develop and test new generic screening concepts:
  - Hybrid screening solutions,
  - Pre-ticketing versus post-ticketing screening,
  - Simultaneous ticketing/screening (e.g., ETD-on-a-Stick), and
  - In-line/bag room solutions.
- Estimate EDS and ETD equipment requirements for each airport.
- Assess system performance at each airport:
  - Queue lengths; and
  - Average, 95th percentile, and max waiting times.
- Assist with selection of preferred solution for each airport.
- Continuous improvement (beyond December 31, 2002).

Use of Simulation for Terminal Planning in a New Environment

- Existing terminal design standards for security and baggage processing space allocation have become obsolete (e.g., FAA Terminal Planning and Design Guidelines and International Air Transport Association Airports Development Reference Manual).
- Need for analytical performance evaluation (e.g., queuing theory) or simulation on case-by-case basis.
- Security/baggage screening is a stochastic process (randomness in processing rate) resulting in overall system performance that is non-linear and may be sensitive to small changes.

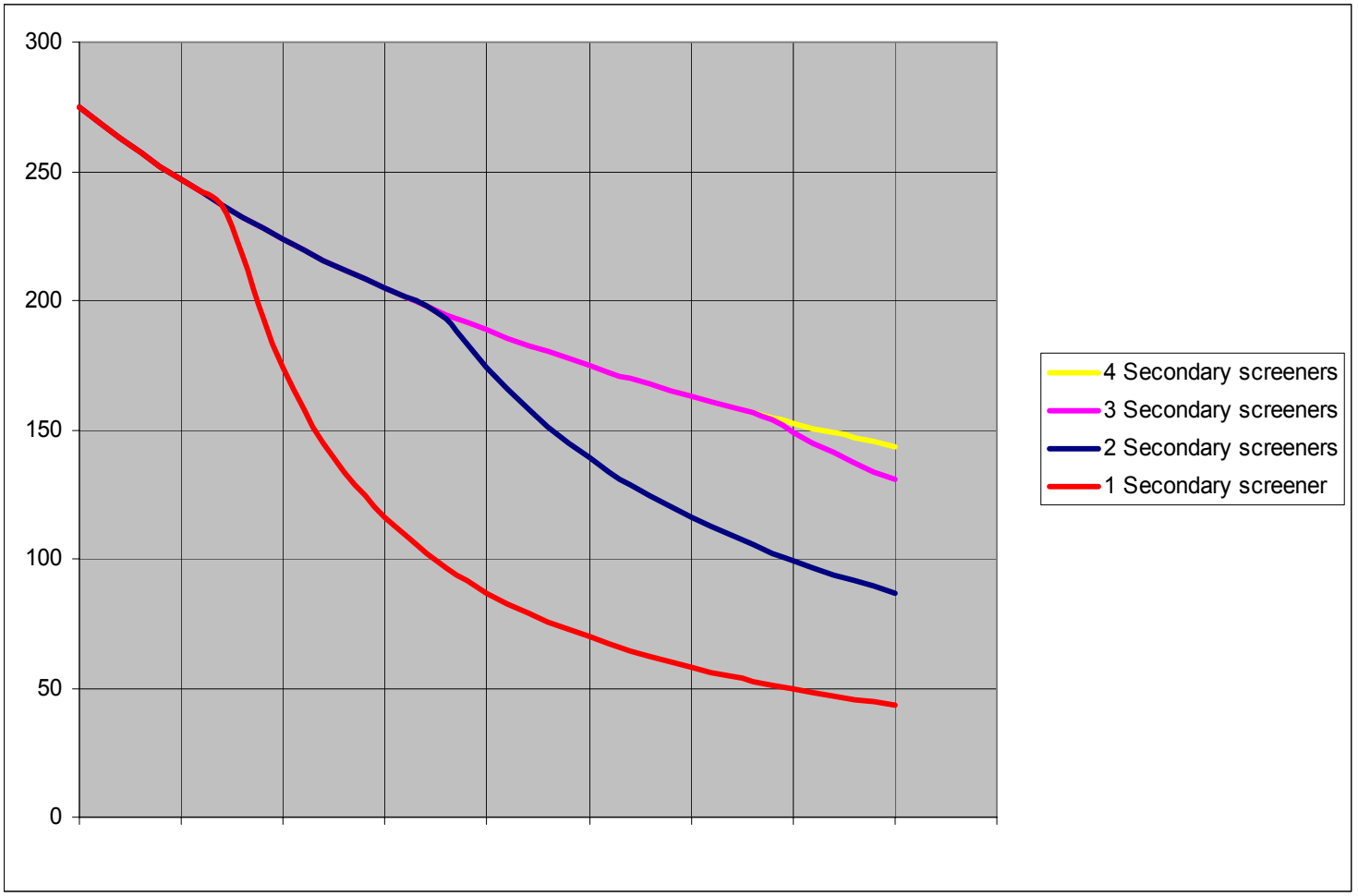


Example of Nonlinear Queuing Effects and Variable Passenger Processing Times

- **Potential risks of using manufacturers' processing times and rates:**
  - Idealized laboratory rates versus real-world achievable rates often differ by a factor of 2; nd
  - Could result in underestimating waiting times and queue lengths by a factor of 4.
- **Potential risks of using average processing times as constants:**
  - Example: System "A" has a constant service time of 2 min; System "B" has a variable service time with an average of 2 min and a standard deviation of 1.5 min.
  - Then, a standard rule of thumb from queuing theory predicts that, for the same demand pattern, the waiting times and queues at System "B" could be twice as long as those at System "A".
- **Potential combined risks:**
  - Using manufacturers' rates and ignoring the variance in processing times rates could result in underestimating waiting times and queue lengths by a factor of 8 (say 5 to 10).

Alarm Rates and EDS Throughput

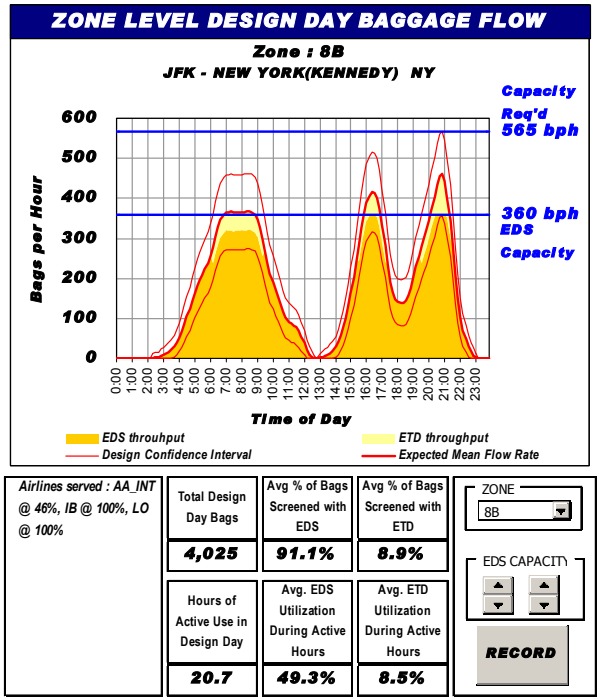
- **A 5-point reduction in alarm rate results in about a 25% increase in EDS throughput.**



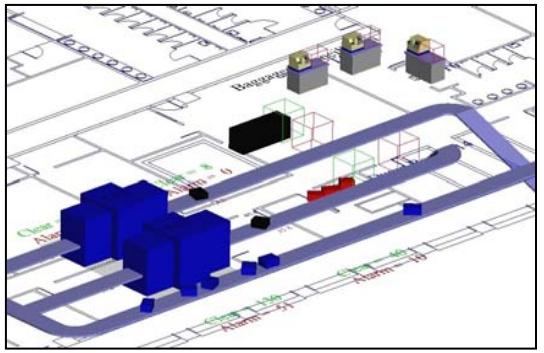
Boeing Team Modeling and Simulation Tools

EDS-SIM (LFA)

PaxSim (Preston)

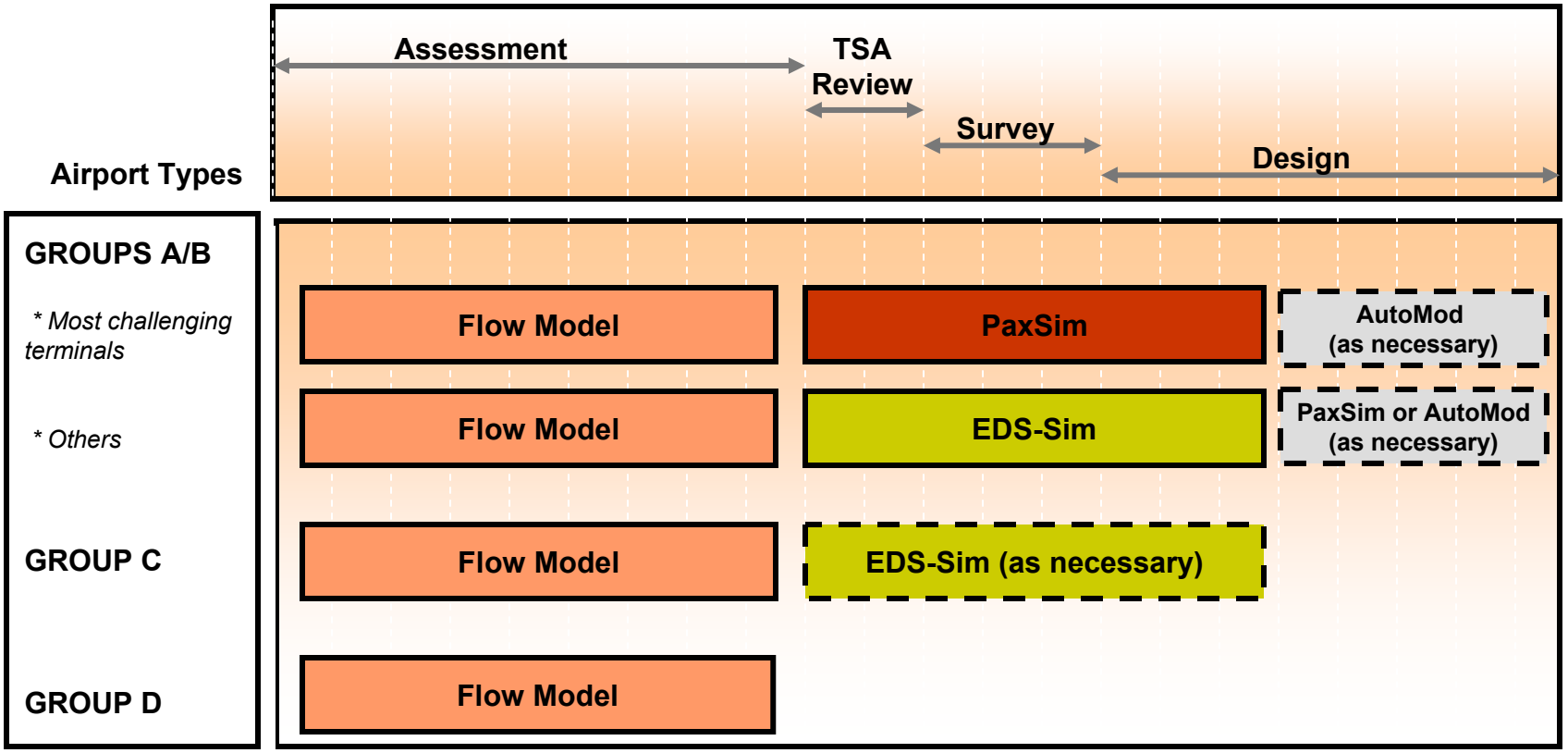


Flow Model (LFA)



AutoMod (commercially available proprietary model)

Modeling and Simulation Strategy



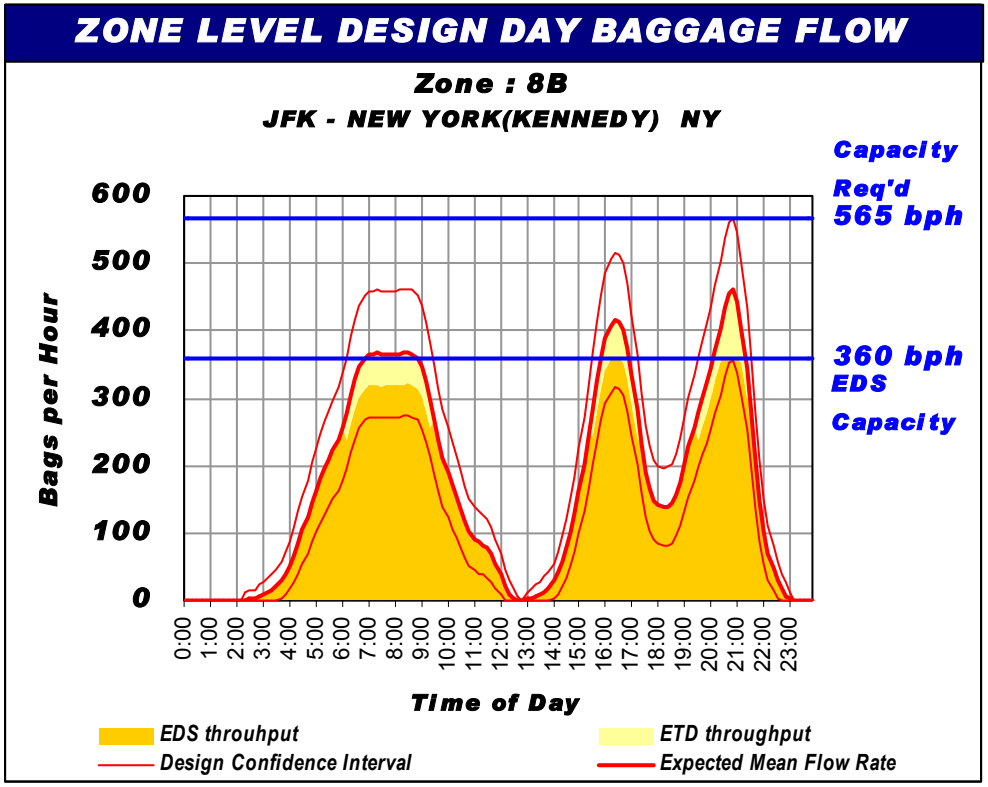
Flow Model = High-level queuing model (concept stage; preliminary requirements)

EDS-Sim = Discrete-event simulation model (design stage; final requirements)

PaxSim = Discrete-event simulation model with animation output (design stage; final requirements)

AutoMod = Discrete-event simulation model with 3D animation output (design stage; final requirements)

Flow Model



Airlines served : AA_INT @ 46%, IB @ 100%, LO @ 100%	Total Design Day Bags	Avg % of Bags Screened with EDS	Avg % of Bags Screened with ETD
	4,025	91.1%	8.9%
	Hours of Active Use in Design Day	Avg. EDS Utilization During Active Hours	Avg. ETD Utilization During Active Hours
	20.7	49.3%	8.5%

ZONE 8B

EDS CAPACITY

RECORD

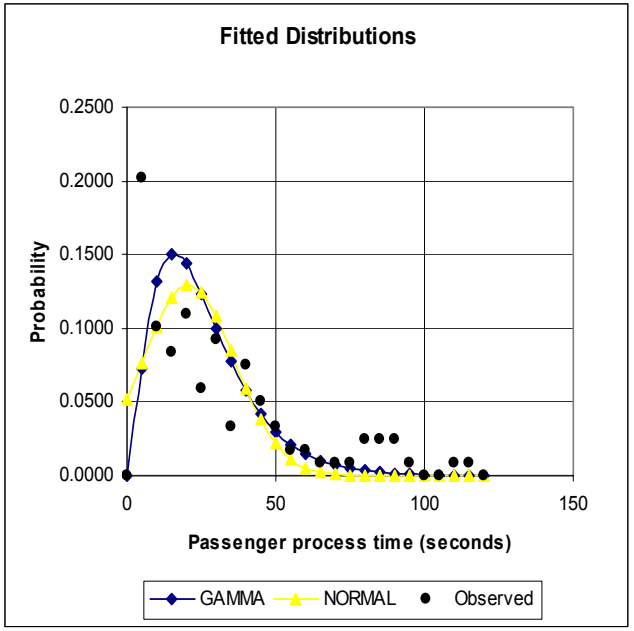
- Based on fluid approximations with statistical surging.
- Used for quickly estimating EDS and ETD equipment requirements for a variety of protocols.
- Integrated with database containing:
  - Official Airline Guide (OAG) schedules,
  - Industry average trends/data,
  - Airline/airport-specific data, and
  - Data collected in field.
- Calibrated to the 10-min performance criteria and redundancy.
- Rapid set-up and application—typically less than 8 h.

- Used for rapid concept evaluation and requirements for most airports where a standard solution is proposed:
  - Modular design to implement solutions from standard set of templates;
  - Captures unique metering/dependency effects associated with pre-ticketing or post-ticketing solutions; and
  - Evaluates requirements based on 95-percentile, 10-min design objective.
- Relatively rapid set up and processing time:
  - Group A: 3 to 5 days;
  - Group B: 2 to 3 days; and
  - Group C: 0.5 to 1 days.
- Integrated with database containing:
  - OAG schedules,
  - Industry average trends/data,
  - Airline/airport-specific data, and
  - Data collected in field.
- Technical details:
  - Discrete event, simulation model; and
  - Pre-processor, a simulation engine, and a post processor modules.

- Fully animated simulation program:
  - Passengers and their luggage modeled visually as individual objects;
  - State-of-the-art, object-oriented modeling environment; and
  - Superior graphics capabilities.
- Appropriate for difficult, controversial layouts:
  - Assist with the refinement of requirements and concept layouts as well as their visualization;
  - Quantify and visualize the impact of congestion on passenger flows and dwell times; and
  - Obtain buy-in for concepts with unique flow/queuing characteristics.
- Relatively rapid set up and processing time:
  - Group A: 8 to 10 days;
  - Group B: 5 to 10 days; and
  - Group C: 4 to 8 days.
- Technical details:
  - Object Oriented Model Development Environment,
  - C/C++ Native Code, Linux Platform,
  - Rule-based decision structure, and
  - Free-flow grid paradigm (not node-link structure as used older technology products).

Data Management

- **Data sources**
  - **Schedule (OAG)**
  - **Airline Data**
    - Transaction statistics
    - Check-in Splits
    - Load Factors
    - % O&D
  - **Field data**
    - Detailed time and queue statistics for 60 airports including all CAT I & II
    - Site survey data for all other airports (429+)
- **Database Repository**
  - **Relational Database**
  - **Processing scripts (SQL/Delphi)**
  - **Schedules**
    - August 2000–March 2003
    - Charter Activity
  - **Processed data for:**
    - Bags/party distribution
    - Party size distribution
    - Check-in splits
    - Load Factors
    - O&D splits
    - Process time distributions

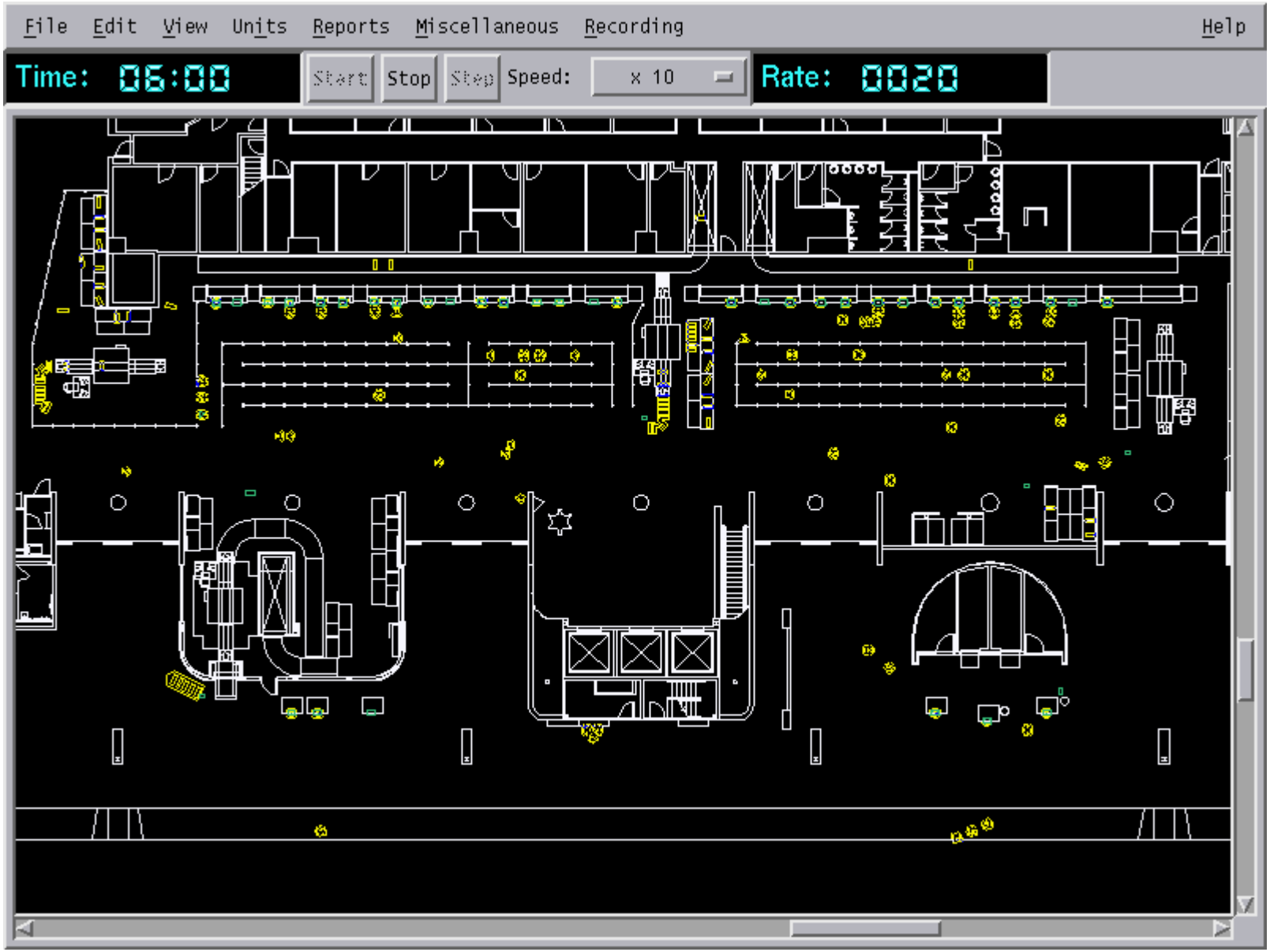


Major Modeling and Simulation Tasks

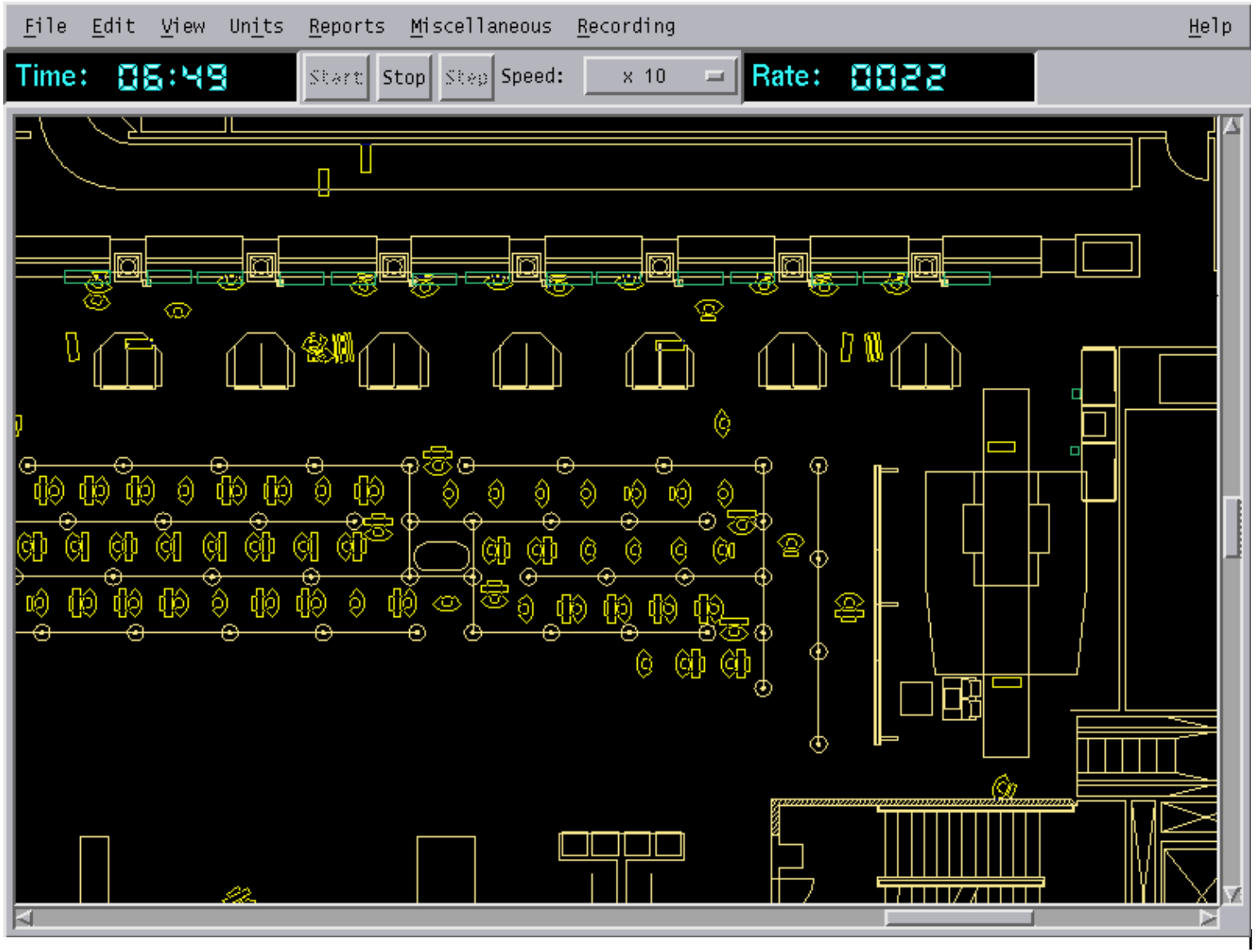
- **Every airport has received some type of modeling:**
  - **Flow Models: 429 airports**
  - **EDS-Sim models: 127 terminals, 90 airports**
  - **PaxSim models: 60 terminals, 30 airports**

- **Development of automation processes and tools necessary for airport system analysis:**
  - **System-wide model to evaluate policy/machine allocation strategies;**
  - **Flow model development and support for use by planners/architects to assess machine requirements; and**
  - **Analysis tools in support of continuous improvement program.**

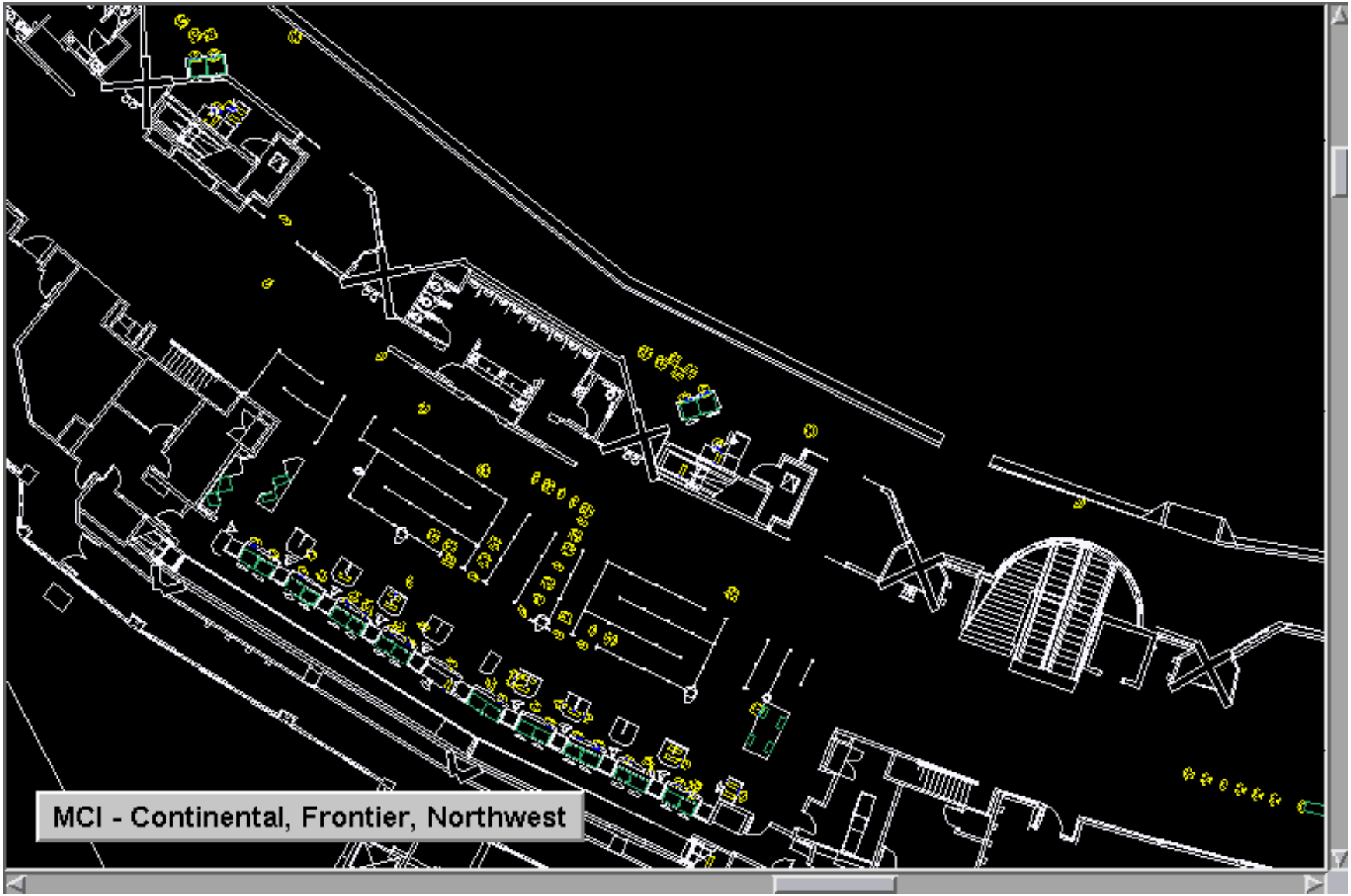
MCO—Post-Ticketing "Drop-n-Go" Concept



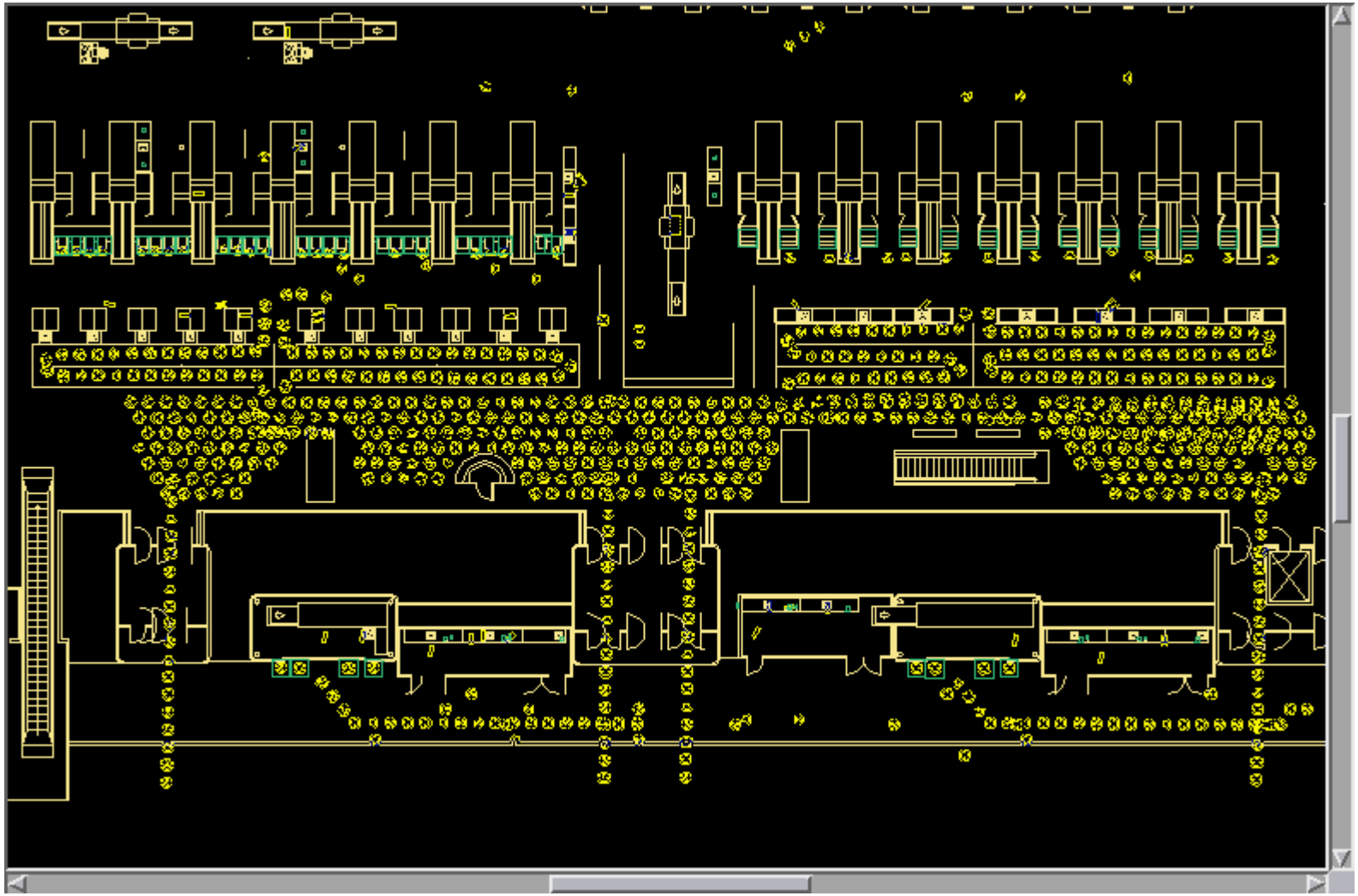
LAX Terminal 1 (SWA)—Simultaneous Screening/Ticketing



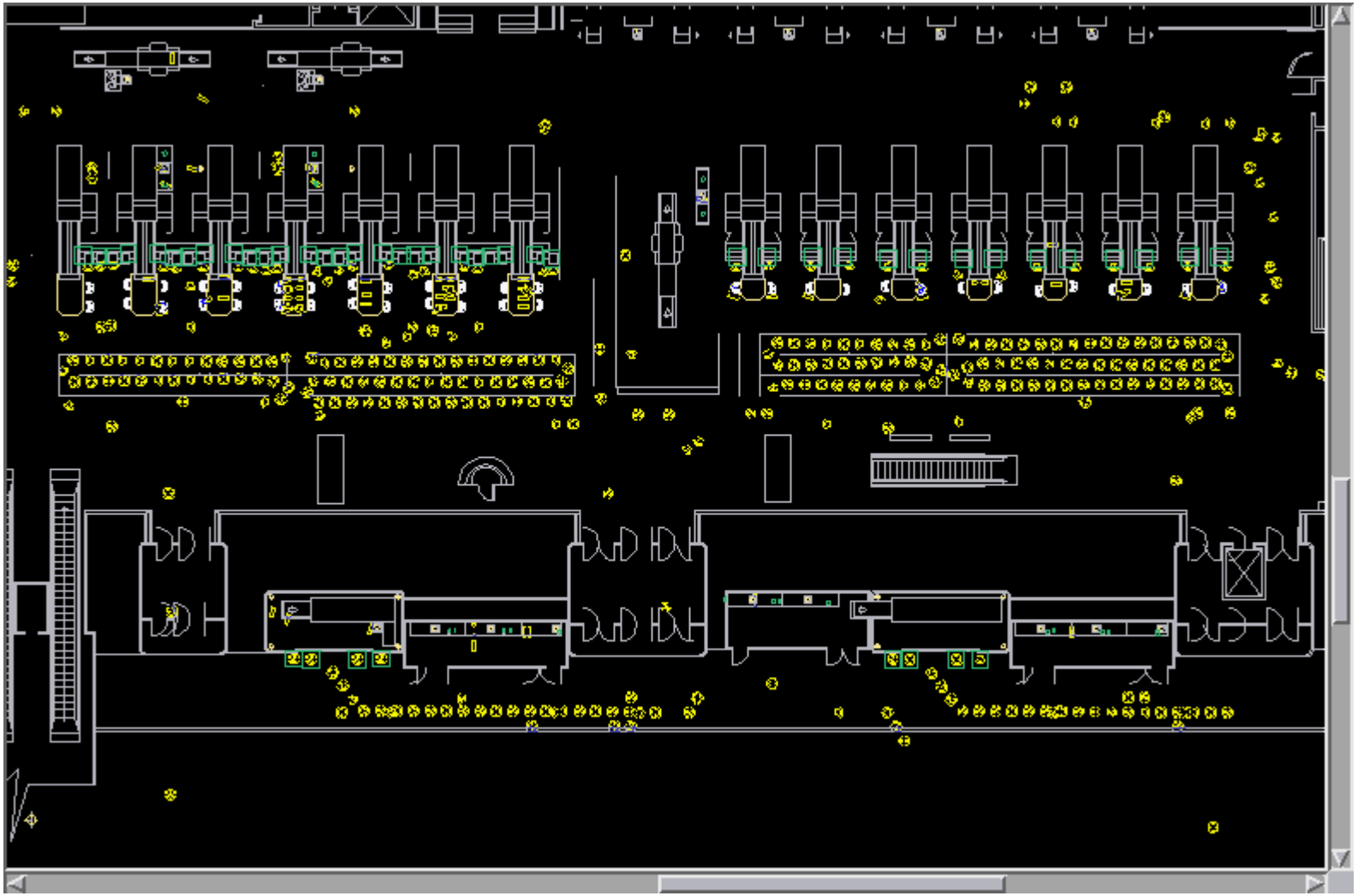
MCI—Simultaneous Ticketing/Screening



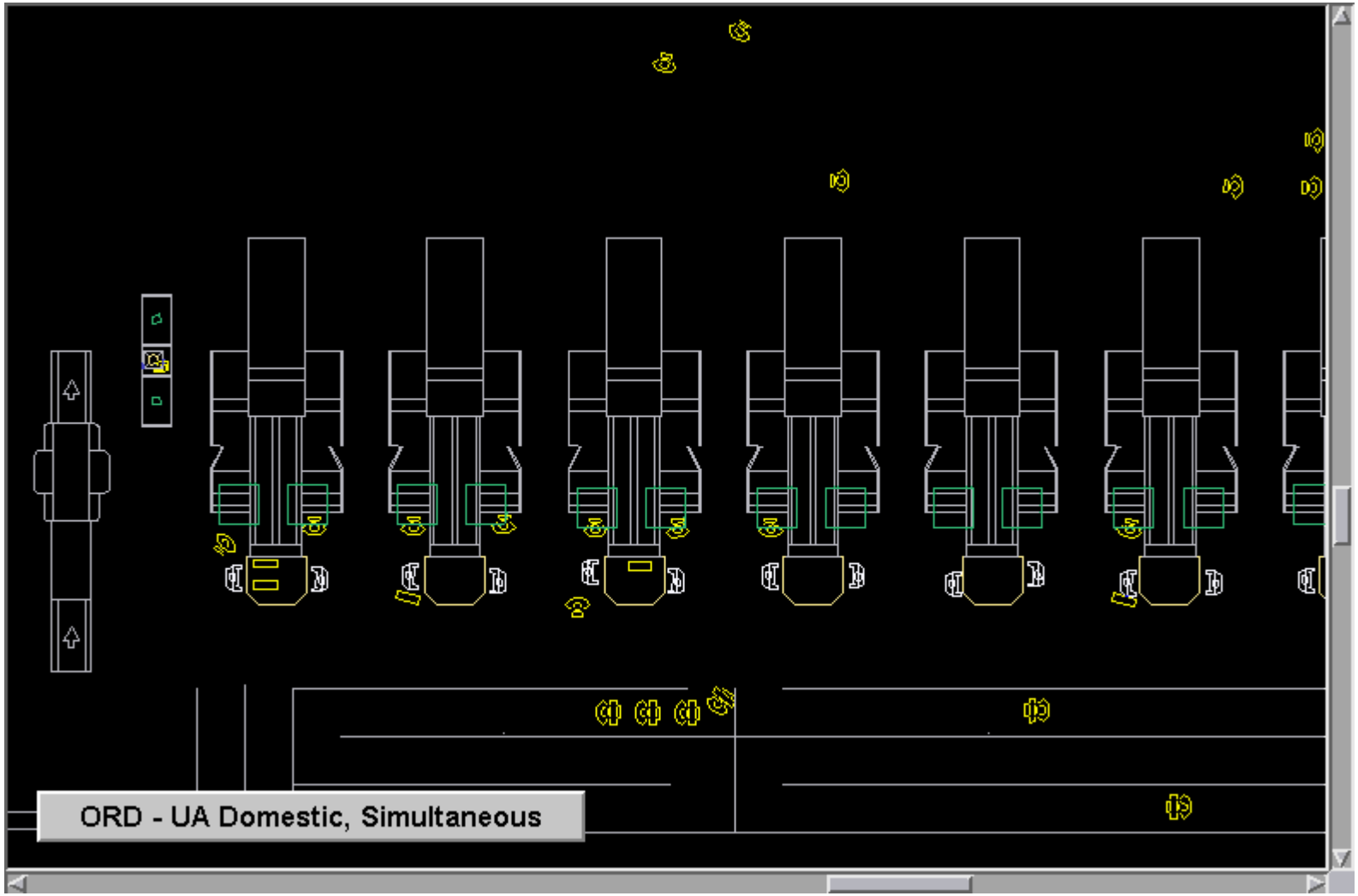
ORD T1 Animation (Original Concept)



ORD T1 Animation (Revised Concept)



ORD T1 Animation (Close-Up)

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