Simulation Modeling Applications
Tom Bradley international Terminal
Los Angeles International Airport

Airport Planning Workshop
Session 3B: Modeling and Simulation Solutions for Terminals

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LAX TEC CORP

Los Angeles World Airports

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A Division of Jacobs Consultancy Inc.

Why Simulation Modeling?

- **Predict the performance of a very complex system (e.g., a passenger terminal)**
- **Test alternative scenarios**
  - Save time and money by understanding what scenarios will not work before they get implemented
  - Quantify operational impacts
  - Get buy-in from airport stakeholders
  - Quickly assess “what if” options
- **Prioritize issues and identify best solution**
  - Identify fundamental operational issues that need immediate attention
  - Quickly lead to optimal solution by eliminating concepts that do not work and refining those that do work
- **If used wisely, it is the best “bang for the buck”**

Case Studies—Tom Bradley International Terminal, LAX

- **Case Study I—Post 9/11 installation of lobby-based baggage screening equipment**
- **Case Study II—In-line baggage screening system**
- **Case Study III—$672 Million Terminal Refurbishment Program**

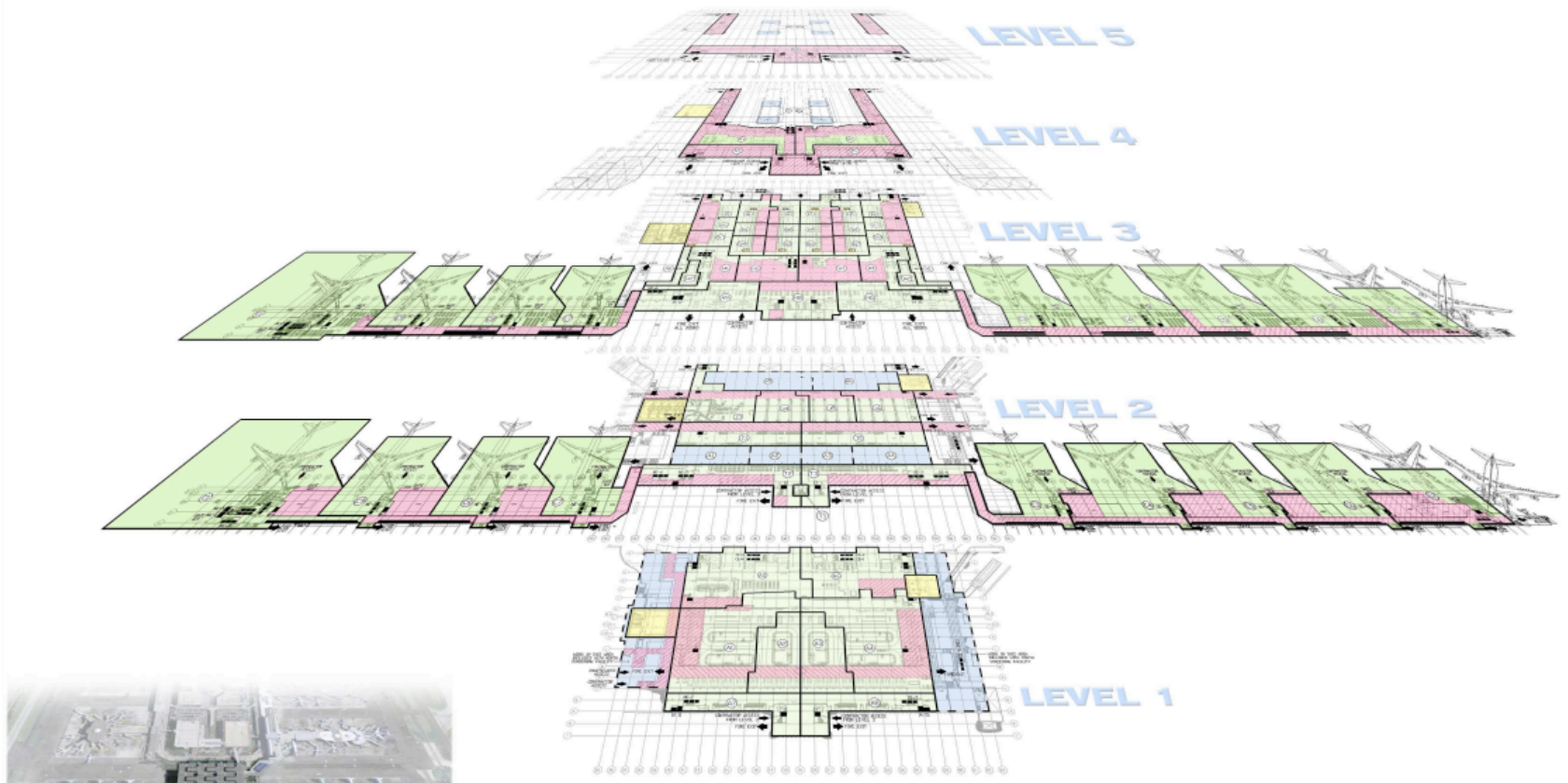
Background on LAX

- **Largest O&D Airport in the World**
- **Considered No.1 on list of probable terrorist targets by California State Attorney General (previously targeted on New Year's Eve 2000)**
- **Nine Terminals**
  - LAWA operated terminals: Tom Bradley International Terminal, Terminals 1, 3, and part of 6
  - Carrier operated terminals: Terminals 2, 4, 5, part of 6, and 7/8
  - Domestic terminals: Terminals 1, 3, 4, 5, 6, and 7/8
  - International terminals: Terminals 2, 4, 5, 7, and TBIT

Background on Tom Bradley International Terminal

- Terminal consists of over 1 million sq. ft., 12 gates, and 5 levels
- 34 airline tenants serving 10 million annual passengers
- Airline operations start at 5 a.m. and cease at 2 a.m.
- Although a major international gateway, 40% of the passengers make connections to/from airlines serving LAX through TBIT, or one of the other 8 terminals
- As a gateway, flight activity is consolidated into two major peaks tied to airline "hub scheduling" in Asia and Europe

Background on Tom Bradley International Terminal



Prepared by:
PARSONS PROGRAM MANAGEMENT TEAM

Los Angeles World Airports

A Typical Day in the Ticketing Lobby

Case Study I—Post 9/11 Installation Lobby-Based Baggage Screening Equipment

Challenges

- Meet the 12/31/02 checked baggage screening mandate by implementing a lobby-based solution in less than 6 months
- Identify "the best" baggage screening layout to accommodate equipment requirement
- Minimize impacts to passenger processing and circulation once lobby-based screening equipment will occupy 40% of lobby floor space in an already congested terminal
- Choose the optimal baggage screening protocol/layout

Case Study I—Post 9/11 Installation of Lobby-Based Baggage Screening Equipment

Simulation Modeling Applications

- Determine equipment requirements that would provide adequate capacity to handle passenger traffic as industry recovers post 9/11
- Assess whether TSA performance standards are met
- Verify that baggage screening times meet airline/LAWA requirements for schedule reliability given finite and limited terminal resources at peak times (i.e., ticket counters and gates)

Case Study I—Post 9/11 Installation of Lobby-Based Baggage Screening Equipment

Simulation Modeling Assumptions

- Summer schedule of 2001
- TBIT operational data (e.g., passenger characteristics) based on field surveys
- LFA Aviation Database
- Bureau of Transportation T100 and OD data for 2001

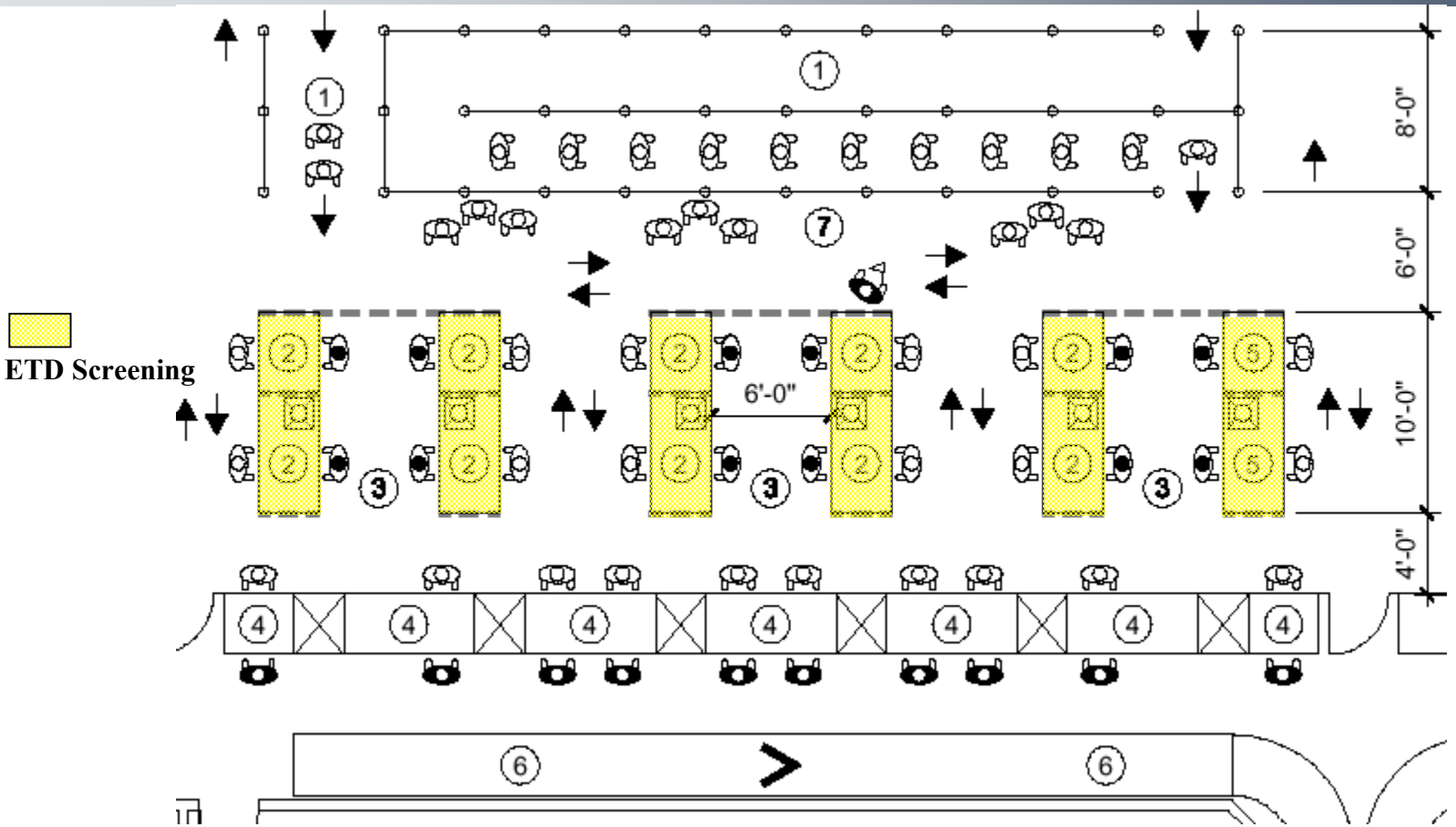
Case Study I—Post 9/11 Installation of Lobby-Based Baggage Screening Equipment

Simulation Modeling, Evaluation Process

- **Alternative screening protocols**
  - 100% ETD pre-ticketing (original LAWA proposed scheme)
  - 100% EDS post-ticketing (TSA preferred scheme)
  - Hybrid: ETD pre-ticketing and EDS post-ticketing ("compromise" scheme)
- **Performance evaluation**
  - Time in screening
  - Overall impacts on passenger circulation around screening areas
- **Selection of preferred alternative**

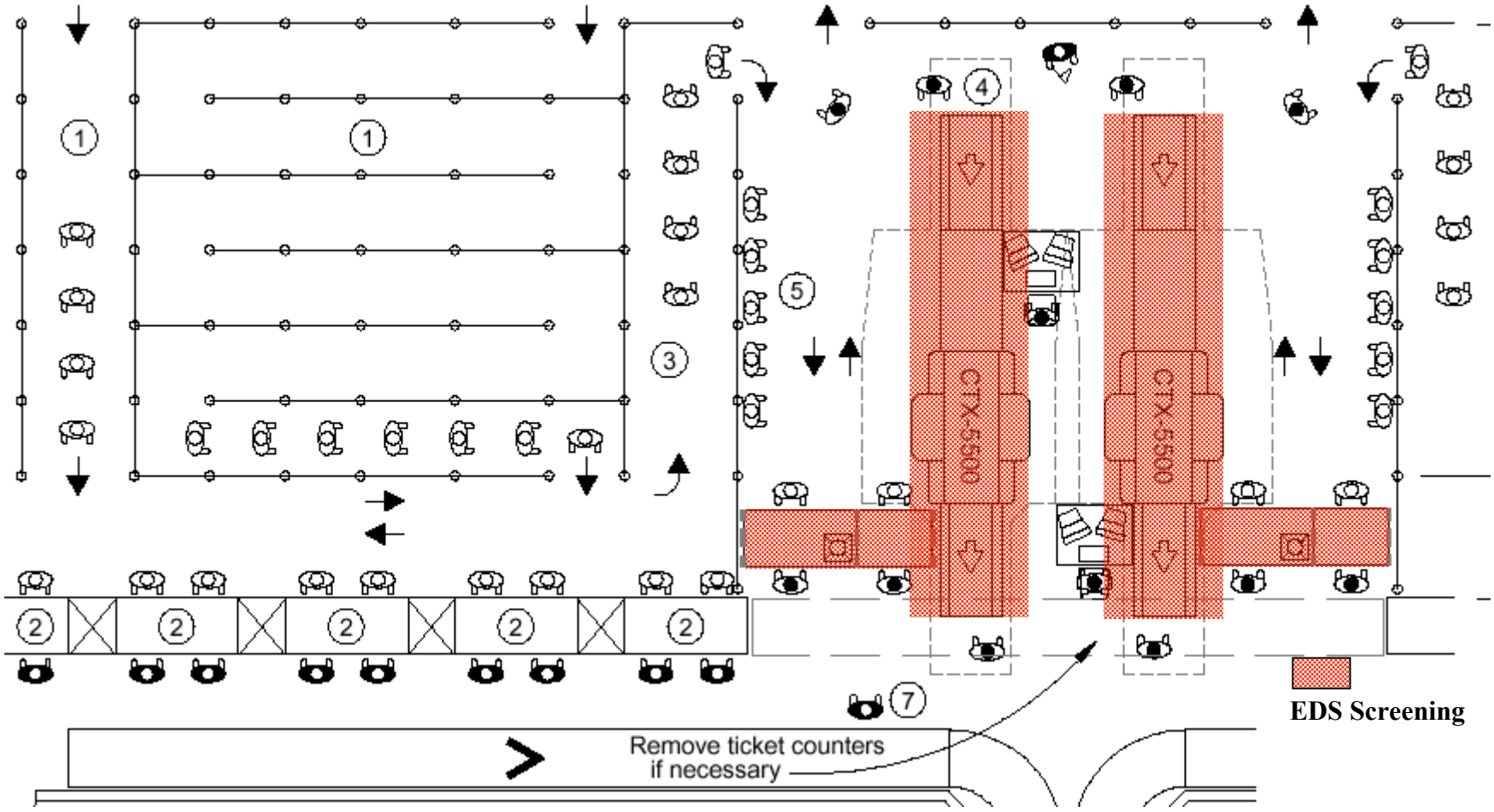
Case Study I—Post 9/11 Installation of Lobby-Based Baggage Screening Equipment

Simulation Modeling, 100% ETD Pre-Ticketing



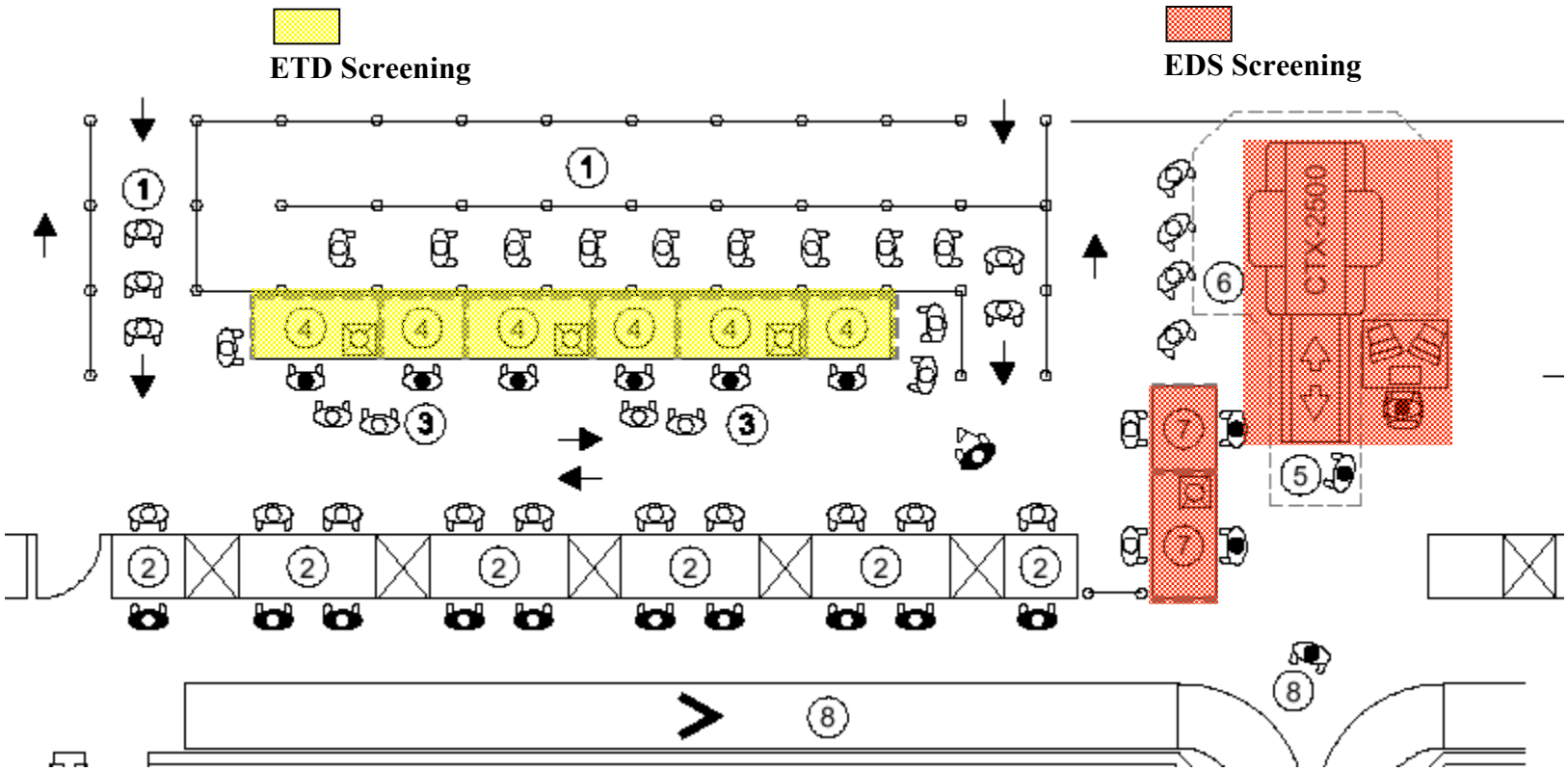
Case Study I—Post 9/11 Installation of Lobby-Based Baggage Screening Equipment

Simulation Modeling, 100% EDS Post-Ticketing



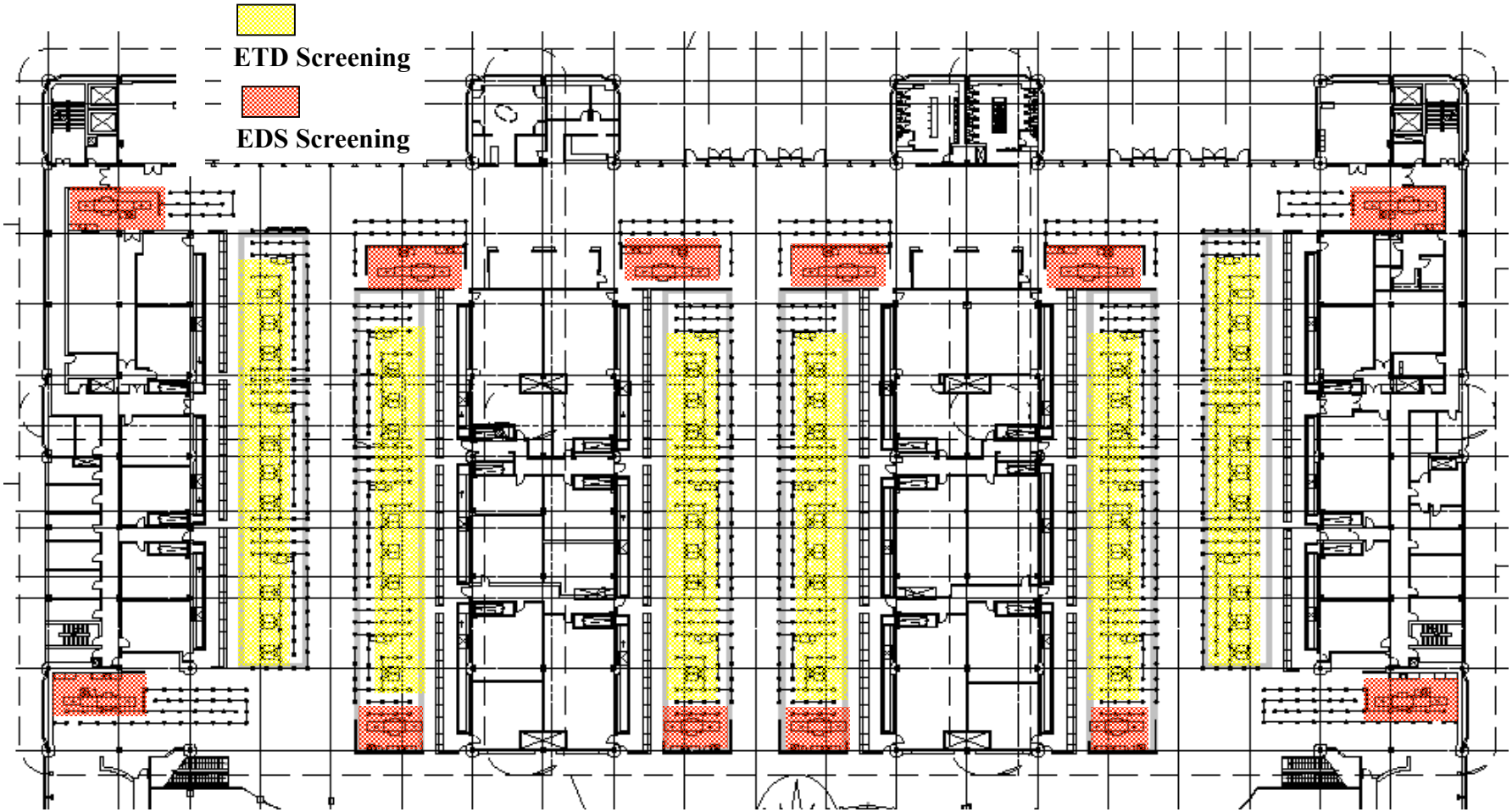
Case Study I—Post 9/11 Installation of Lobby-Based Baggage Screening Equipment

Simulation Modeling, Hybrid Scheme

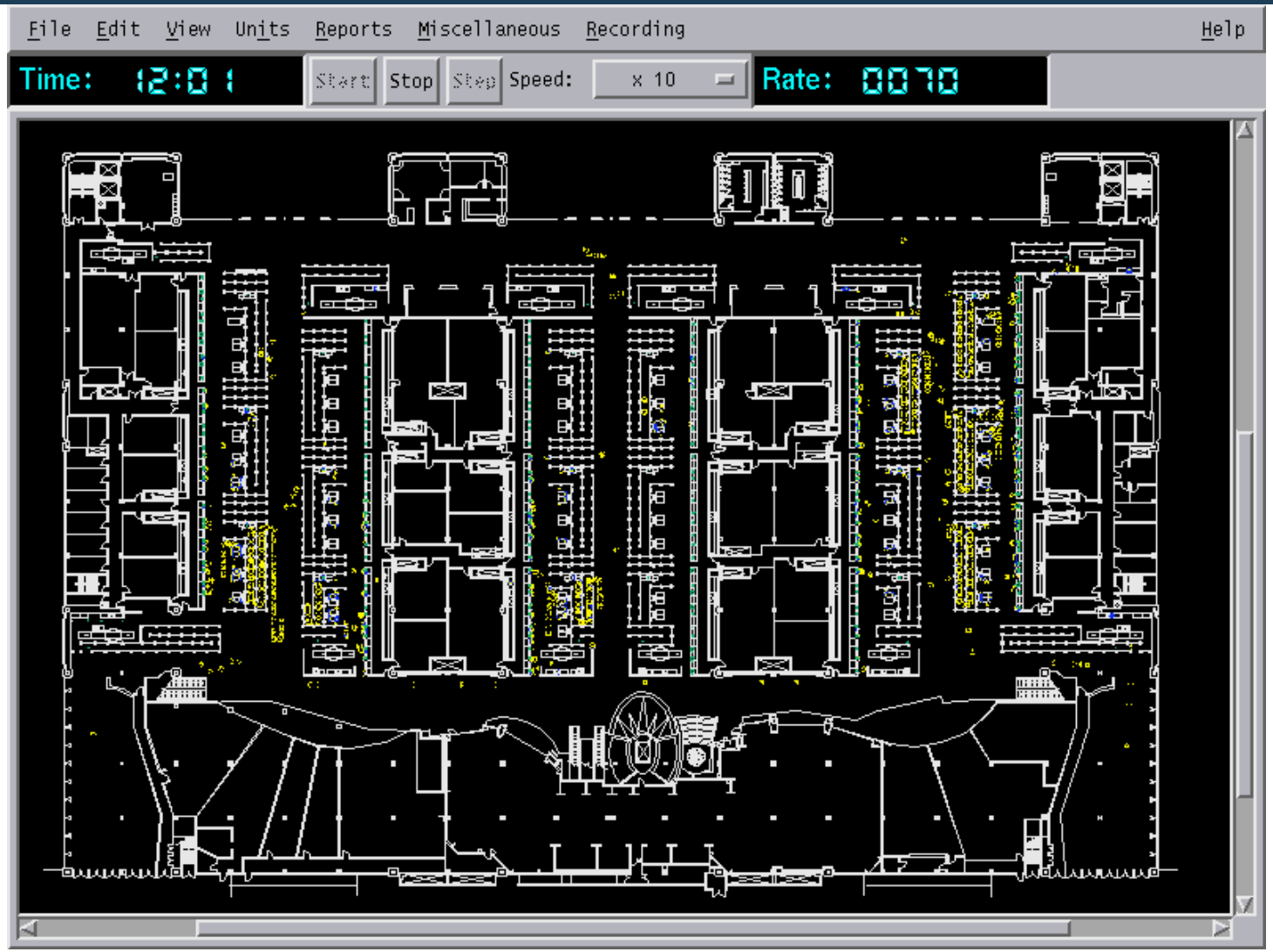


Case Study I—Post 9/11 Installation of Lobby-Based Baggage Screening Equipment

Simulation Modeling, Preferred Concept



Case Study I—Post 9/11 Installation of Lobby-Based Baggage Screening Equipment



Case Study I—Post 9/11 Installation of Lobby-Based Baggage Screening Equipment

Findings

- **Simulation demonstrated that the initial proposed template was not viable at TBIT**
  - TBIT physical design and passenger circulation patterns are unique
  - Passenger characteristics (arrival times, party size, amount of checked baggage), passenger processing times, and number of well-wishers are very different from other terminals
  - Several schemes were rejected because the location and the amount of the required screening equipment had negative impacts on passenger processing and circulation
- **Simulation focused decision-making into key areas**
  - Choice of the appropriate screening protocol (pre- vs. post-screening and ETD vs. EDS screening) to minimize passenger queues, waiting times, and overall congestion
  - Location of screening equipment to minimize impacts on passenger circulation

Case Study II—In-Line Baggage Screening System

Challenges

- Identify "the best" in-line baggage screening layout to accommodate equipment requirement in the available space
- Guarantee enough flexibility to accommodate traffic growth, future screening technology, and new TSA screening protocols
- Meet the needs of TSA, airlines, and other airport stakeholders

Case Study II—In-Line Baggage Screening System

Simulation Modeling Applications

- Determine equipment requirements that would provide adequate capacity to handle passenger traffic expected 5 years after DBO
- Assess whether TSA performance standards are met
- Verify that baggage screening times and overall BHS travel times meet airline/LAWA requirements for schedule reliability
- Test if baggage screening systems have adequate redundancy even during machine-down conditions
- Test if baggage screening system can accommodate future technology (higher throughputs, lower false alarm rates)

Case Study II—In-Line Baggage Screening System

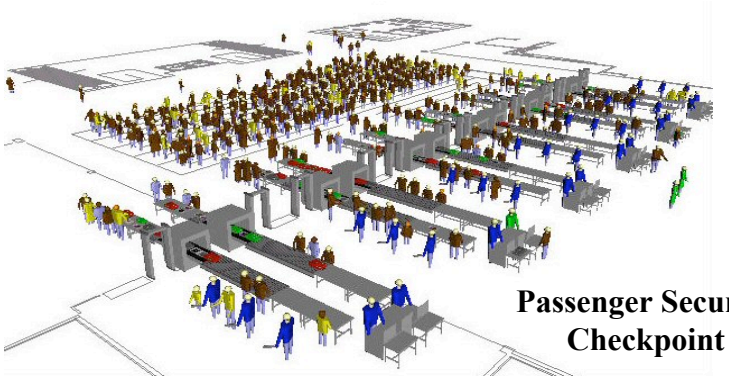
Simulation Modeling Assumptions

- Design Year: 2008
- TBIT operational data (e.g., passenger characteristics) based on field surveys
- EDS equipment screening assumptions based on TSA and equipment manufacturers' specifications
- LFA Aviation Database
- Bureau of Transportation T100 and OD data for 2004

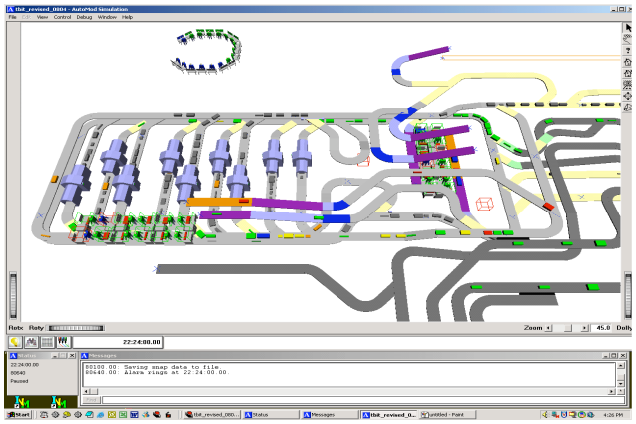
Case Study II—In-Line Baggage Screening System

AutoMod Simulation Model

- **Commercially available from Brooks PRI Automation**
- **3-D visual output**
- **Includes conveyor and vehicle modules**
- **Based on a fixed path modeling paradigm**
- **User-defined code written to control load movement**
- **Primary applications**
  - Checked baggage screening
  - Passenger security checkpoints
  - Passenger check-in processes



Passenger Security Checkpoint



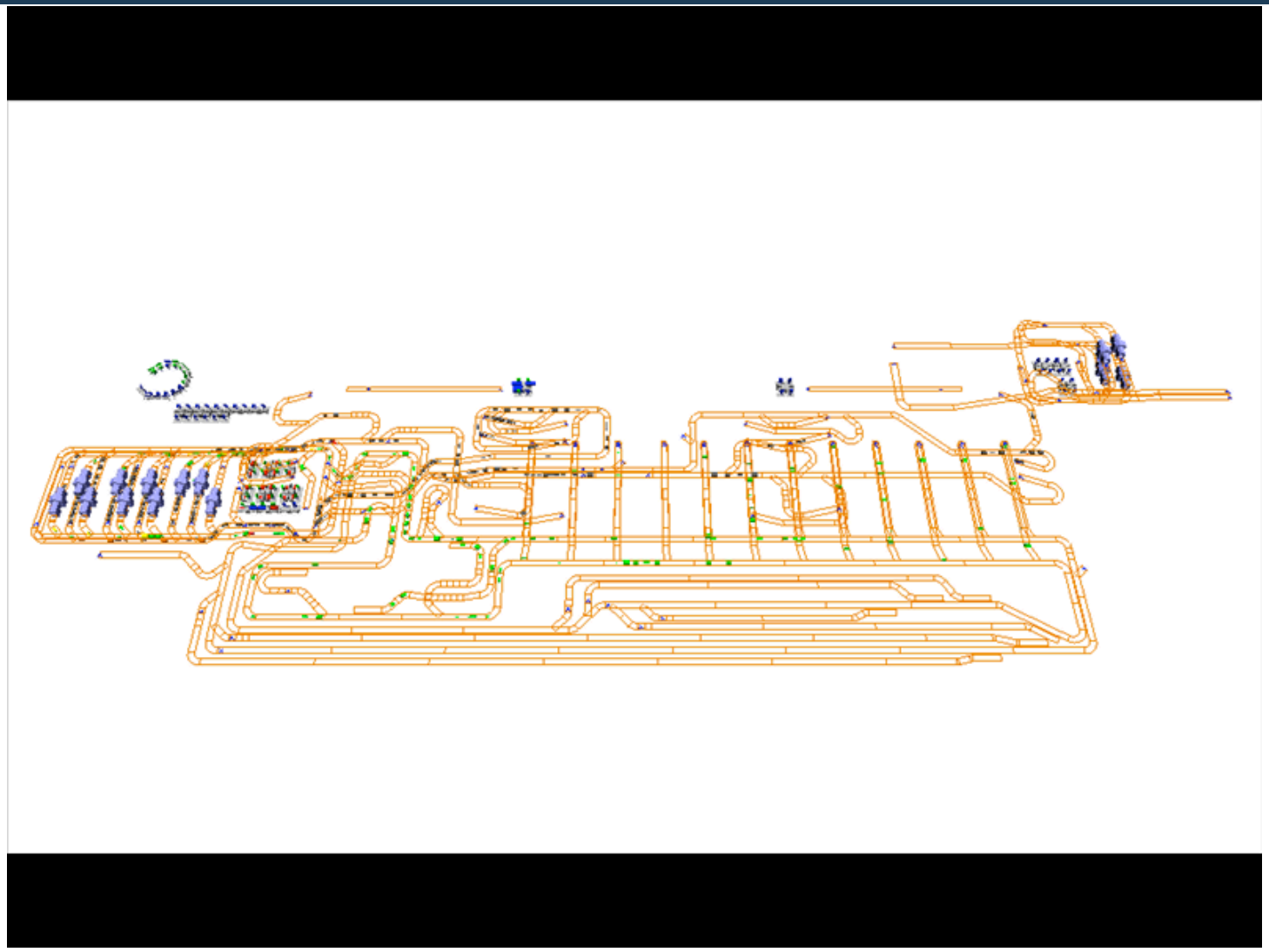
Checked Baggage Screening

Case Study II—In-Line Baggage Screening System

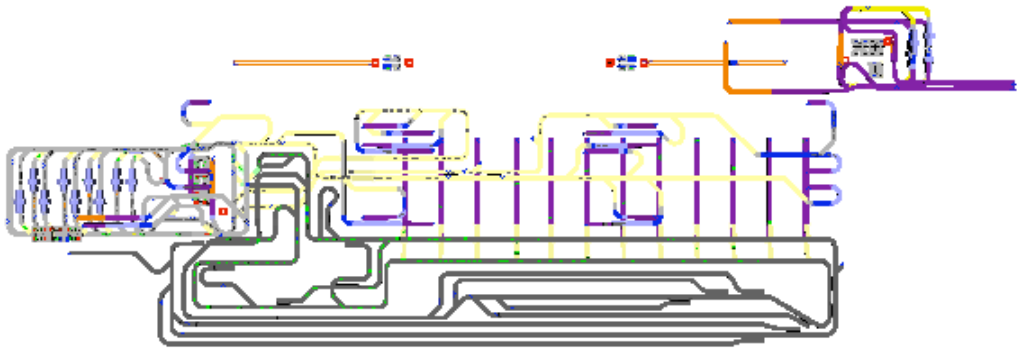
Simulation Modeling, Evaluation Process

- **Alternative system layouts**
  - 9-EDS machine system
  - 10-EDS machine system
- **Performance evaluation**
  - Number of EDS machines required and their utilization
  - Time in system
  - Mixing of bags with different status
- **Selection of preferred alternative**

Case Study II—In-Line Baggage Screening System



Case Study II—In-Line Baggage Screening System



Case Study II—In-Line Baggage Screening System

Findings

- **Simulation demonstrated that the 9-EDS machine system performed better than the 10-EDS machine system**
  - The same demand level can be screened by 9 EDS machines in a more efficient layout
  - EDS machines are better utilized with a double common recirculation loop as opposed to two independent loops
  - Two baggage inspection rooms provide more flexibility and redundancy than a single one
  - The 9-EDS machine system minimizes mixing of bags with different status
- **Simulation allows us to focus on key areas**
  - Specific areas that needed to be improved were identified and modified
  - The revised system was significantly improved

Case Study III—TBIT Refurbishment Program

Challenges

- **Continued operations during construction**
  - One of the most complex construction projects within the U.S. in the past two decades
  - Operations have to be maintained during a 38-month construction project
- **Phasing/cost implications**
  - Consolidated phasing gives the General Contractor the ability to work on large portions of the terminal, thus saving time and money
  - Reduced passenger processing, baggage screening capacity, and circulation space in an already congested facility
- **Transition to new "in-line" baggage screening system**
  - Phasing implications on TSA screening operations from a lobby-based to a full in-line system

Case Study III—TBIT Refurbishment Program

Simulation Modeling Applications

- **Continued operations during construction**
  - Determine which airlines generate more passengers during peak hours
  - Assess the impacts of relocating lobby-based baggage screening to different locations within lobby during construction
  - Evaluate congestion during different phases of lobby construction
- **Phasing/cost implications**
  - Determine the optimal phasing plan (e.g., how much and which portions of lobby construction had greatest impacts on congestion)
- **Transition to new "in-line" baggage screening system**
  - Develop transition plan for TSA and airlines to switch from lobby-based to fully automated in-line baggage screening systems

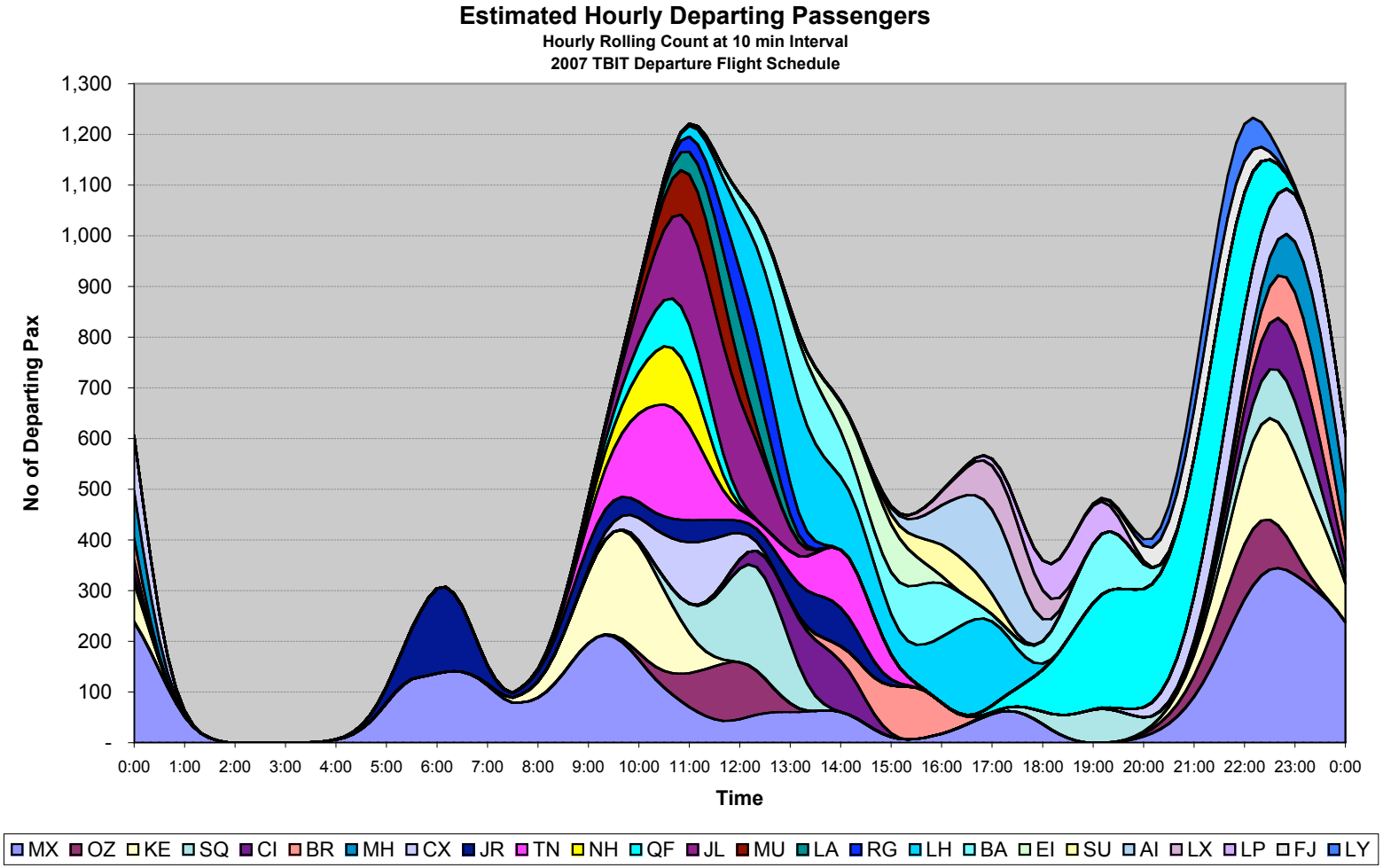
Case Study III—TBIT Refurbishment Program

Simulation Modeling Assumptions

- Summer schedule of 2005
- Additional departing flights based on available forecast
- Selected flights changed to A380 with 555 seats
- TBIT operational data (e.g., passenger characteristics)
- LFA Aviation Database
- Bureau of Transportation T100 and OD data for 2004

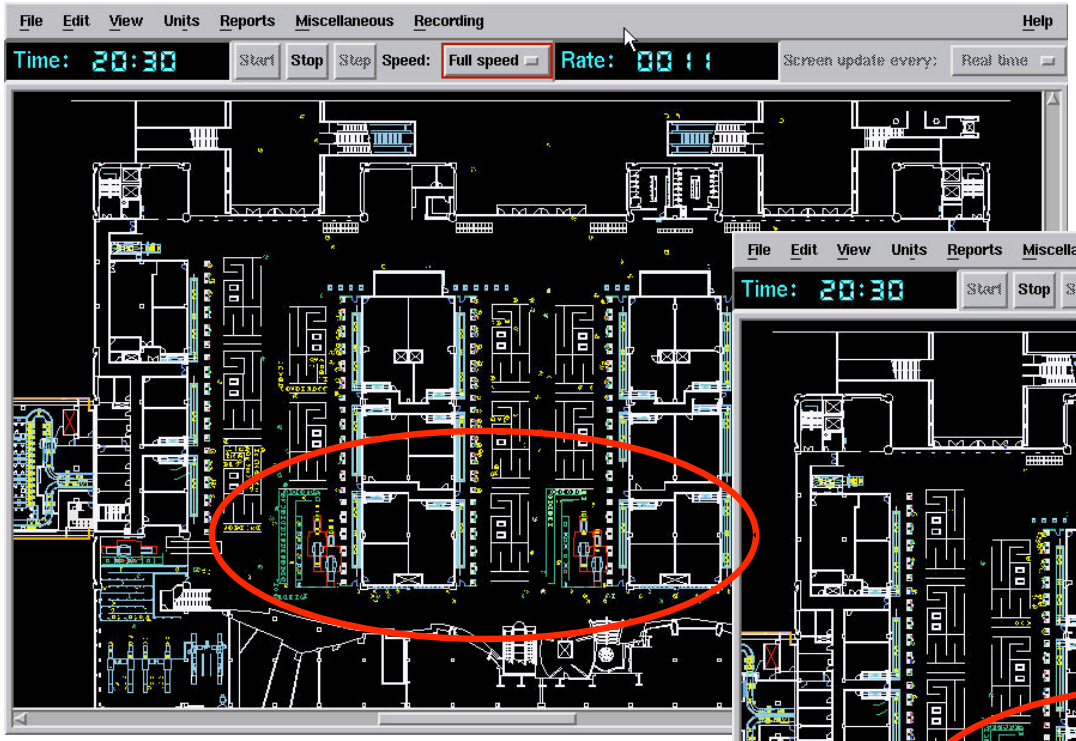
Case Study III—TBIT Refurbishment Program

Simulation Modeling, Passenger Flows

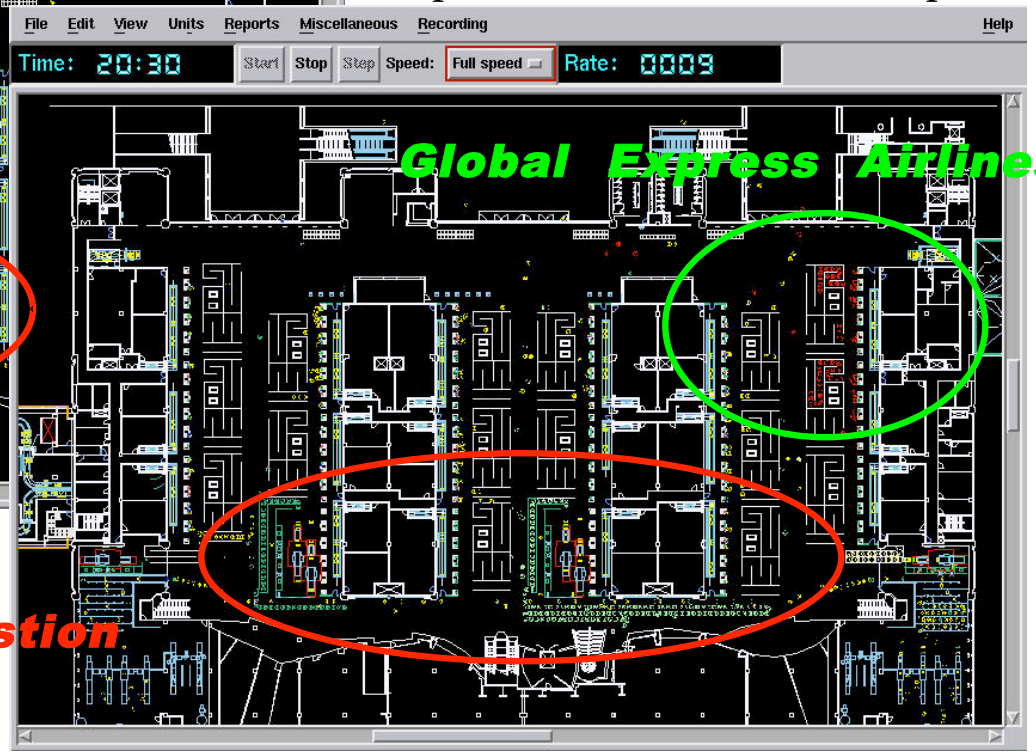


Case Study III—TBIT Refurbishment Program

Simulation Modeling, Alternatives Comparison



Departure Level without Global Express



Departure Level with Global Express

Difference in EDS congestion

Case Study III—TBIT Refurbishment Program

Case Study III—TBIT Refurbishment Program

Findings

- **Simulation confirmed that construction will cause high levels of congestion in the ticketing lobby**
  - Alternative construction phasing options were explored, and the most promising one was selected; however, impacts on congestion are going to be severe
  - The relocation of screening equipment in the lobby and the change in screening protocol have some positive benefits, but something more drastic has to be implemented
- **Simulation assessed the impacts of the relocation of a single airline to an alternate space on the arrivals level**
  - Evaluation of various options identified “Global Express” relocation as the most effective solution
  - It was proven to “Global Express” senior and local management that passenger and baggage processing and screening operations will improve with relocation to lower lobby

Summary of Simulation Benefits

- **Focus on what works and what doesn't**
- **Model different scenarios**
- **Quantify impacts of variables and compare different solutions**
- **Focus those areas that generate best return on investment**
- **Provide assessment of entire system – strengths and vulnerabilities**
  - One solution may create numerous other problems
  - Help to define "weakest link" or "critical path" item in problem resolution
- **Timely/cost-effective analysis that can continue to be refined based on new available data**

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