



Traffic Simulation Modeling for Nuclear Power Plant Evacuation Time Estimate Studies

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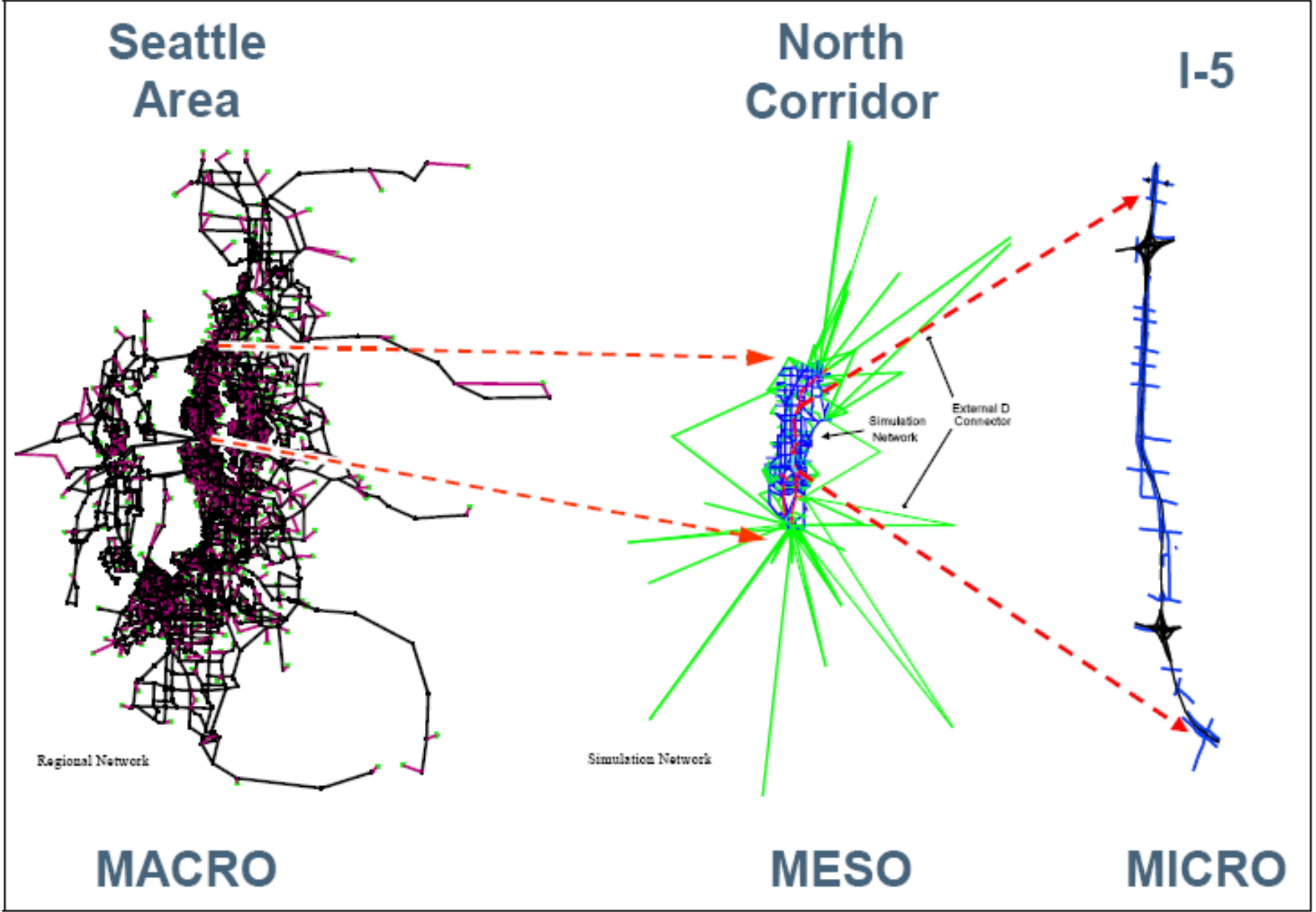




Modeling and Simulation

- **Modeling attempts to find analytical solutions and predict the behavior of a system based on a set of parameters and conditions. Models uses objects to represent a system in a form other than itself – they may be qualitative or quantitative.**
- **Simulation is broader and (here) involves computers to run groups of models to mimic or reproduce the desired essence of a real system, without reality**





Traffic simulation scale and detail
 (Hardy and Wunderlich 2008)



Traffic Simulation for NPP ETEs

- Traffic simulation modeling is an improvement over simple demand to capacity comparisons for the type of complex analyses required for an ETE, but it is necessary to develop ETEs in a transparent manner
- Modeling must incorporate numerous temporal and spatial elements to represent the evacuation traffic process
 - Travel demand
 - Origin-Destination
 - Departure time
 - Trip routing
 - Ambient activities
 - Dependent evacuees
 - Background traffic and Shadow evacuation





Traffic Simulation for NPP ETEs

- Traffic modeling focuses on the “supply side” of the supply-and-demand relationship
- To represent roadway capacity, key elements of the road network must be collected and coded
 - Roadway design, including lanes, shoulders, toll gates, speed limits, etc.
 - Traffic control
 - Weather conditions
 - Day or night
- Measures of Effectiveness (MOEs) are established for use in evaluating the traffic simulation activities
 - Flow volumes
 - Travel time
 - Queue length
 - Total outflow
 - Average speed





Traffic Simulation for NPP ETEs

- **Key performance characteristics derived from model output will provide these MOEs**
- **Most importantly, the total evacuation time for a variety of conditions**





Traffic Simulation for NPP ETEs

- Once the data and assumptions are obtained and established the traffic simulation model can be developed.
- In the last decade, many traffic simulation models have been used to support evacuation analyses, including macro-, micro-, and meso- scale
- The USDOT sponsored publication “*Evacuation Management Operations Modeling Assessment: Transportation Modeling Inventory*,” provides a useful description of evacuation models that may be used in the development of ETEs.

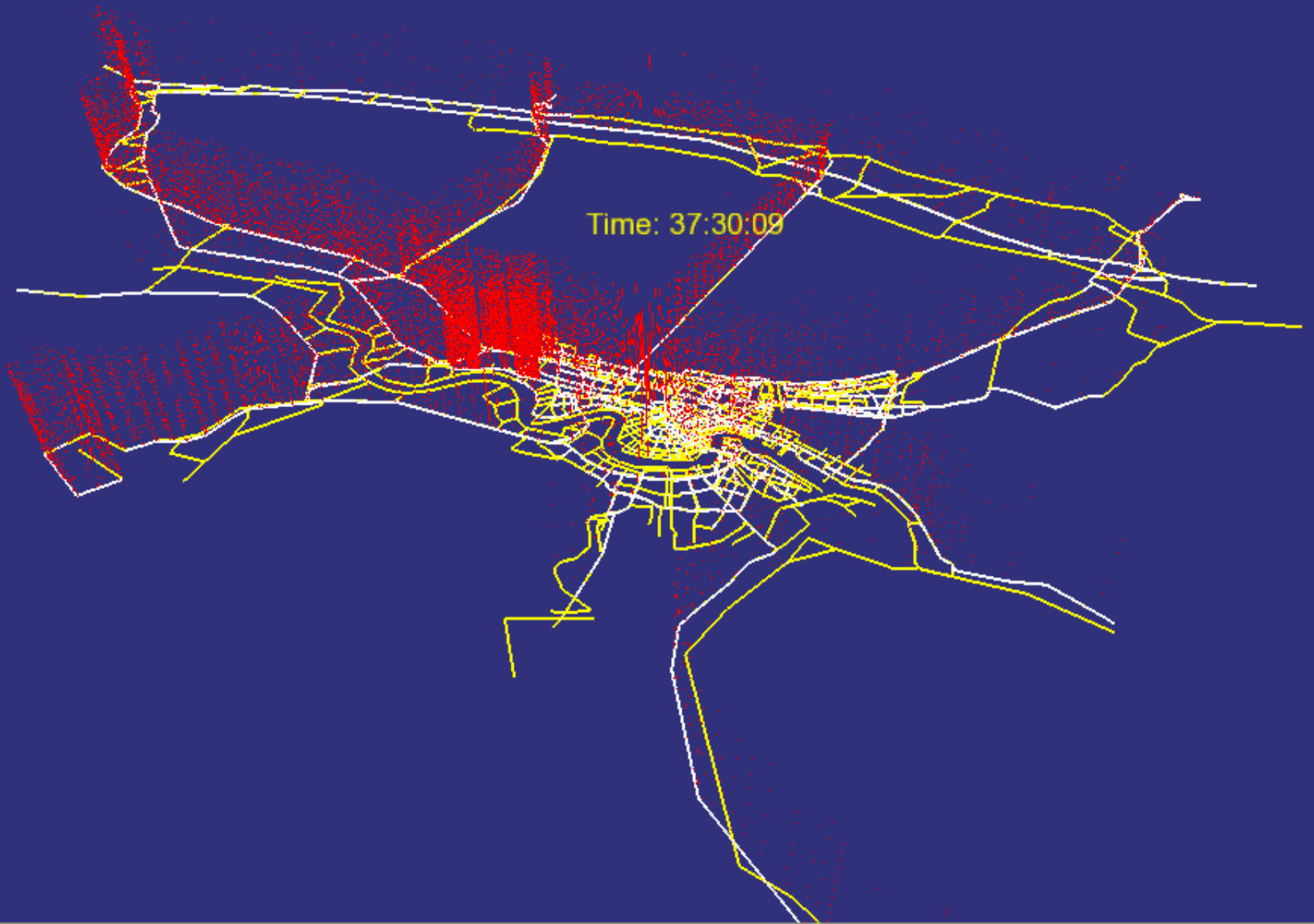




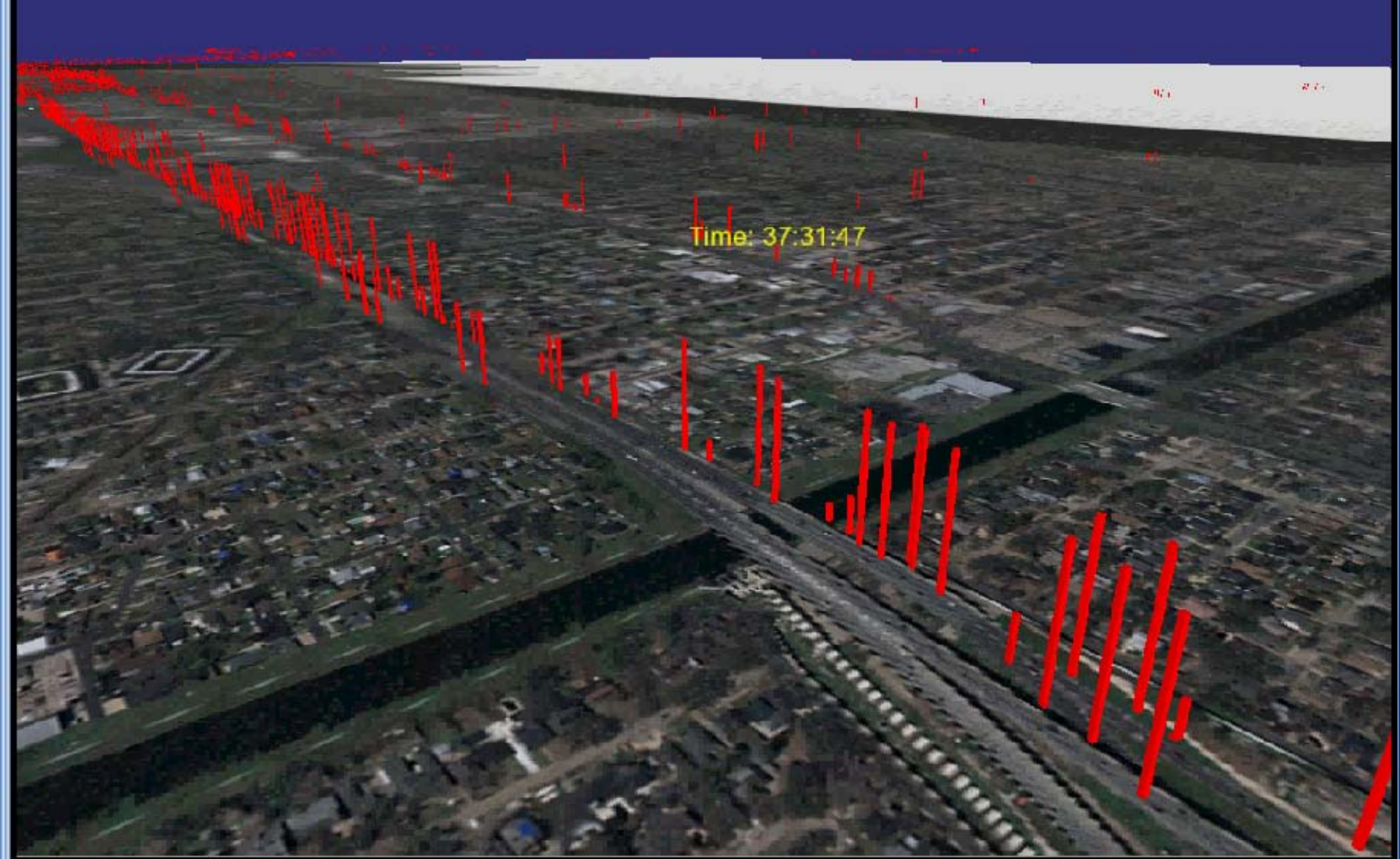
Simulation Model Selection

- **A model is selected based upon factors such as:**
 - The size of the area in consideration;
 - The fidelity of the analysis required;
 - The complexity of the expected inputs (i.e., distributions of data; etc.)
- **In concept, the approach is simplistic:**
 - The roadway network is mapped into the model using a system of nodes and links.
 - Vehicle data is input at centroids, or loading nodes
 - The analysis begins.
- **In practice, it is not quite that simple**





New Orleans evacuation simulation TRANSIMS regional road network

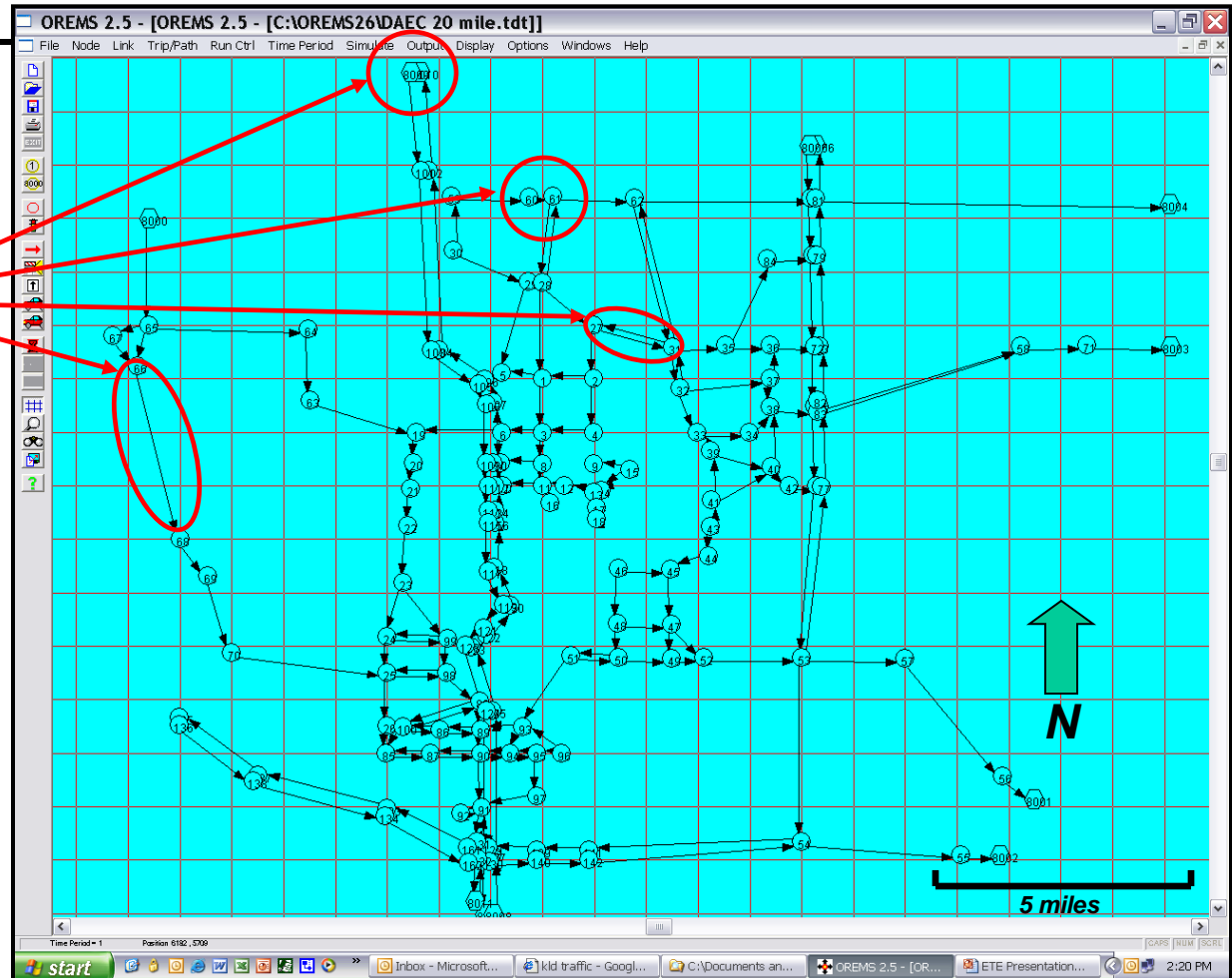


New Orleans evacuation simulation animation (screen shot)

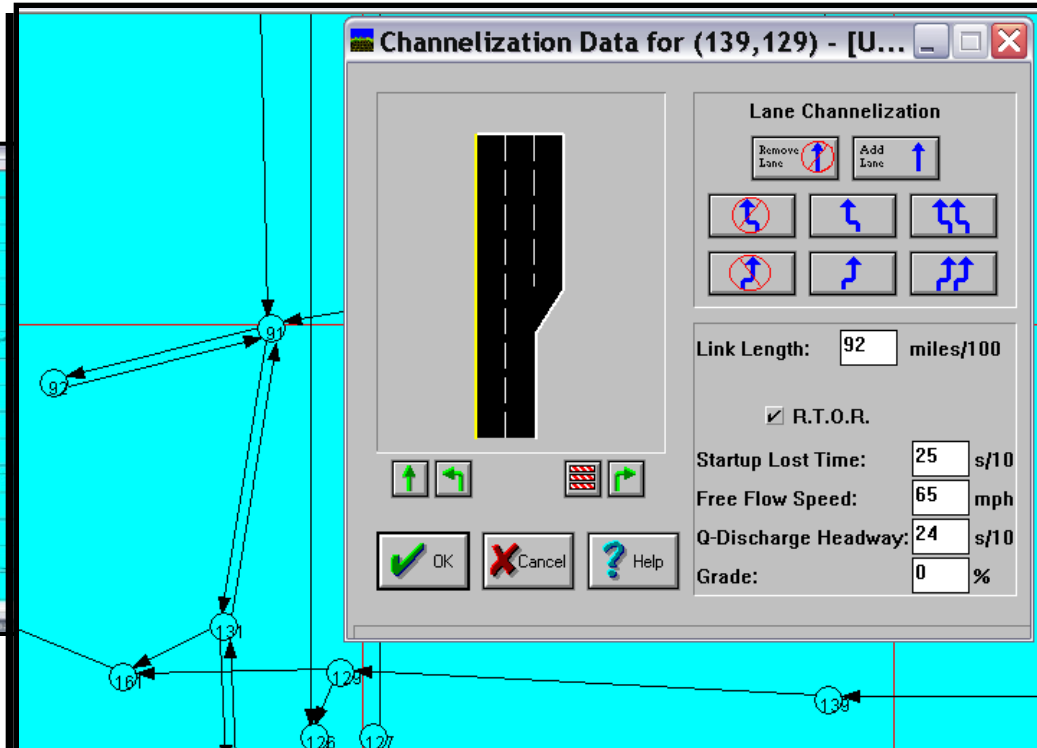
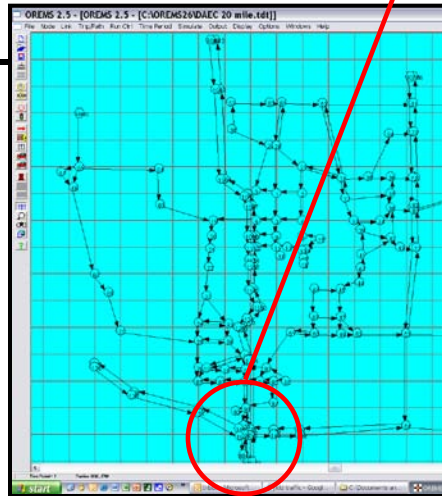
Modeling Process



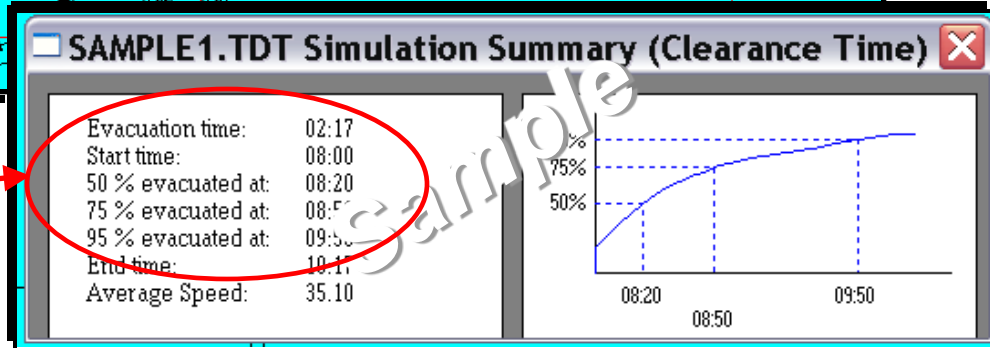
- **Grid
“Nodes”
& “Links”
based on
roadway
layout**



Modeling Process



- Nodes, links, centroids, origin-destinations, and other parameters are defined
- Evacuation time estimate outputs are generated





Traffic Simulation Model Input

- **Traffic simulation model assumptions and input parameters are needed to support analysis. A representative set of model inputs is needed such as:**
 - **Roadway capacity values;**
 - **Total vehicles entering the network;**
 - **Vehicle load factors (persons per vehicle);**
 - **Time based vehicle loading curves for origin nodes;**
 - **Data input at origin nodes;**
 - **Directional preference; and**
 - **Destination nodes and capacities.**

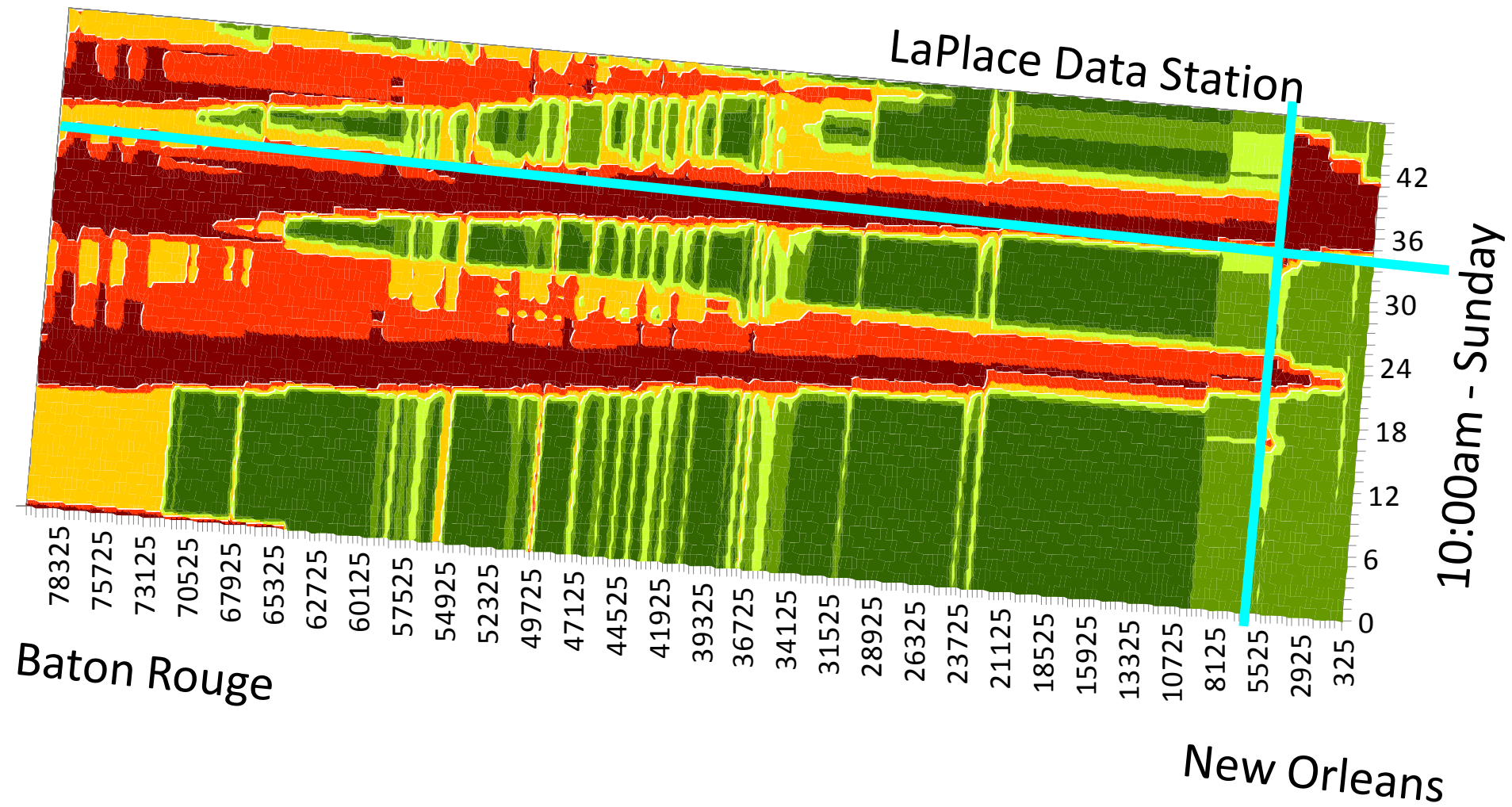




Model Output

- **The model output needs to be developed to support review. Helpful output information would include such items as:**
 - **Total volume and percent of vehicles by hour at each EPZ exit node;**
 - **Average travel time;**
 - **The longest queue length for the 10 intersections with the highest traffic volume;**
 - **Total vehicles exiting the network;**
 - **An evacuation curve which describes the cumulative percentage of evacuees who have exited the EPZ; and**
 - **Average speed for each roadway segment that exits the EPZ.**





Westbound I-10 Traffic Speed



Summary

- **Traffic simulation modeling is the predominant method of developing ETEs**
- **Use of modeling allows the analyst to include detailed infrastructure and population characteristics that influence the evacuation time**
- **As discussed in this presentation, there are many elements included in the ETE, all of which must be considered to assure that the ETE is representative of the expected response.**
- **Questions?**

