

Evolution of a Chicago Region TRANSIMS Application

Hubert Ley

Transportation Research and Analysis Computing Center

Energy Systems Division

Argonne National Laboratory

August 24, 2012

About Argonne: One of DOE's Largest Research Facilities

<http://www.anl.gov/>



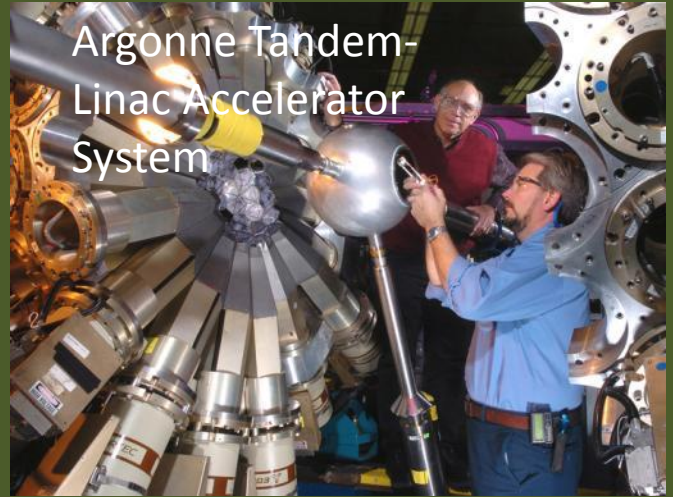
- Located 25 miles from the Chicago Loop, it was the first national laboratory, chartered in 1946
- Operated by the University of Chicago for the U.S. Department of Energy
- Major research missions include basic science, environmental management, and advanced energy technologies
- About 3,000 employees, including about 1,000 scientists and engineers, of whom 750 hold doctorate degrees
- Annual operating budget of about \$475 million (80% from DOE)
- Since 1990, Argonne has worked with more than 600 companies and numerous federal agencies.



User facilities at Argonne



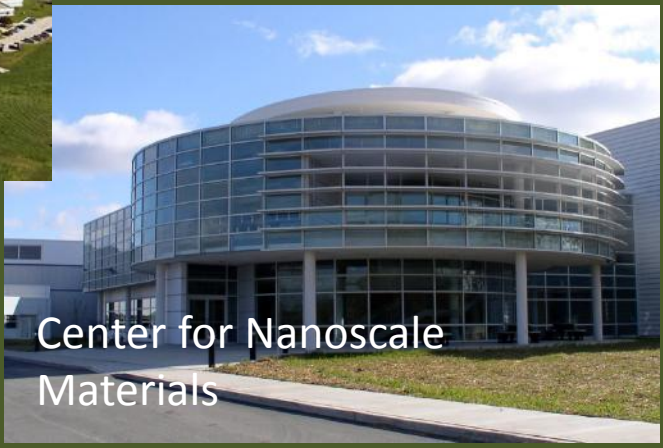
Advanced Photon Source



Argonne Tandem-Linac Accelerator System



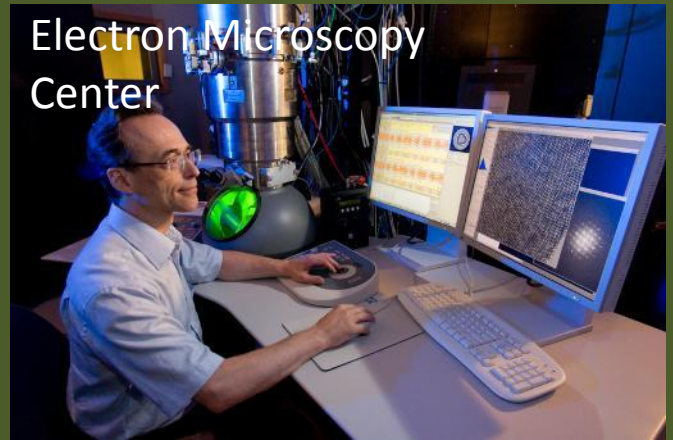
Transportation Research and Analysis Computing Center



Center for Nanoscale Materials



Leadership Computing Facility



Electron Microscopy Center

TRACC - A National User Facility to Meet USDOT Advanced Computation Needs

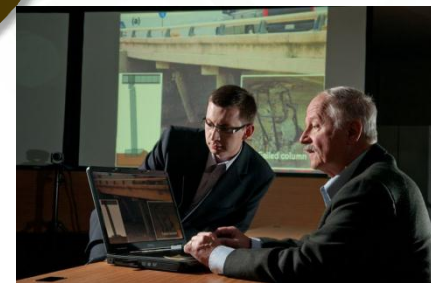
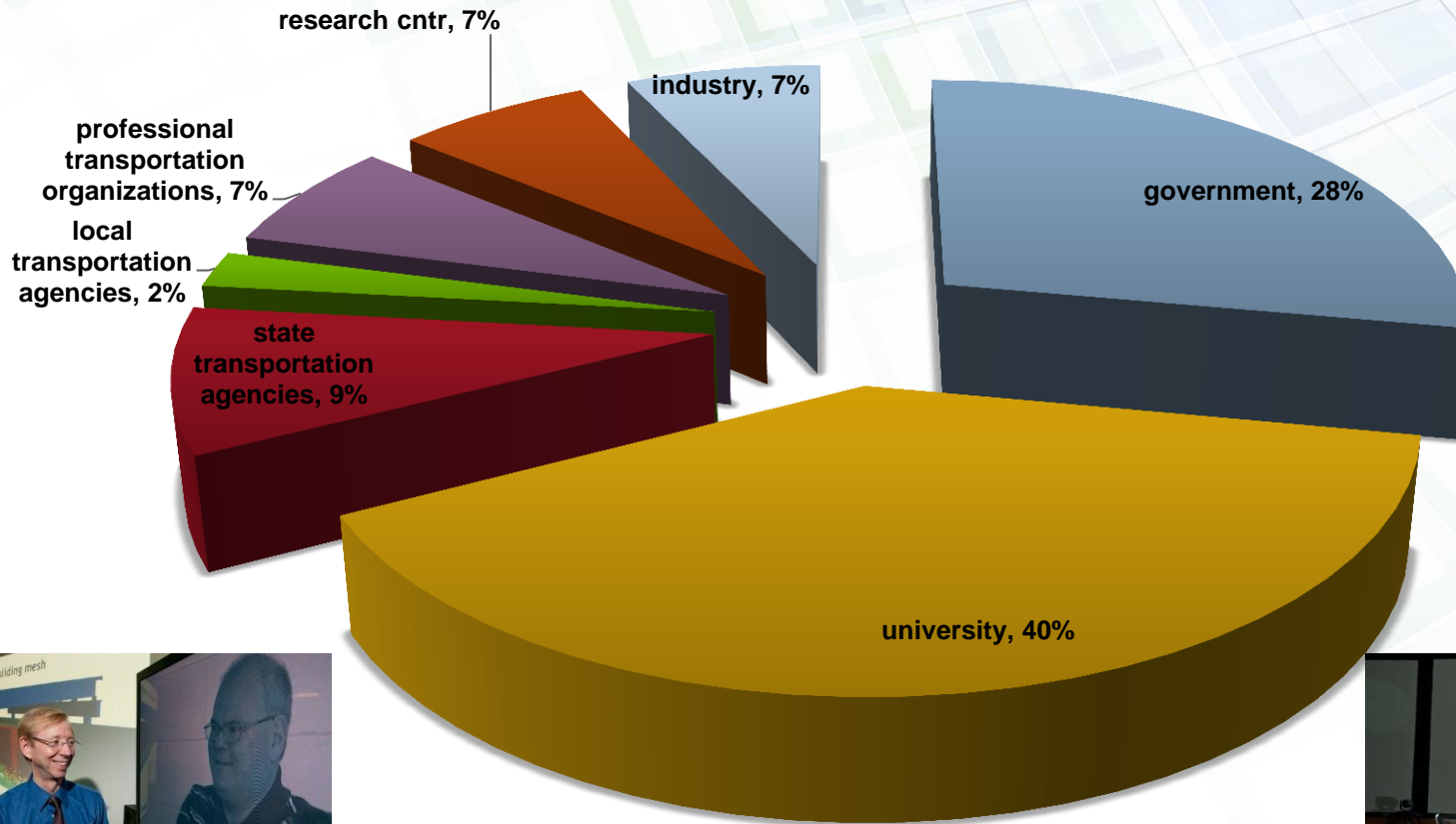
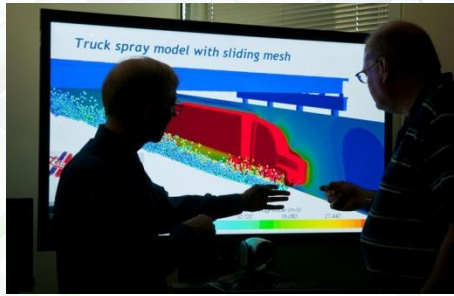
- USDOT and USDOE transportation research programs, private industry, and state and regional transportation agencies are moving to simulation-based design and analysis for improvements in efficiency, economics, and safety
- Higher fidelity analysis in areas such as crashworthiness, aerodynamics, combustion, thermal management, weather modeling, and traffic simulation require access to state-of-the-art computational and visualization facilities
- Argonne expertise in high-performance computing and transportation system analysis provides the basis for a national HPC user facility and a focal point for computational research for transportation applications



TRACC User Profile

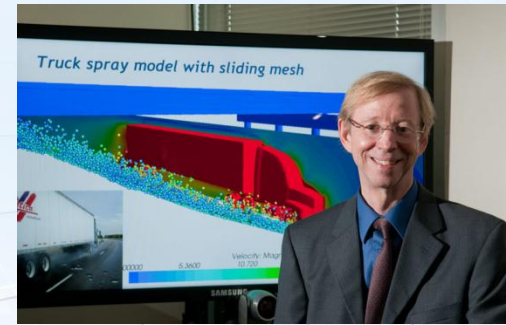
TRACC Cluster User Groups

January - March, 2011



Computational Fluid Dynamics and Computational Structural Mechanics

- Commercial applications such as LS-Dyna, adapco Star-CD, and adapco Star-CCM+ scale well on a cluster of this particular design
- Based on proven and reliable commercial models, **cutting edge research** involves the addition of crucial modeling capabilities such as
 - **Sediment relocation** at bridge pier foundations
 - Parametric vibrations in **bridge stay cables**
 - Many more ...



High priority **transportation-related issues** are “messy” and need robust and well-calibrated methodologies in the hand of many agencies and consulting companies

- TRACC provides a **platform that is substantially larger** than an existing platform available to transportation researchers
- TRACC focuses on **calibration and validation** of cutting edge modeling approaches



TRANSIMS User Support and Training



Argonne
NATIONAL LABORATORY

TRANSIMS
Training Course
April 21 -23, 2008
West Chicago, Illinois

Location
The training course will be held at the DuPage Airport Flight Center in West Chicago where Argonne's TRACC offices are located. The training sessions will be held on the third floor of the flight center at the University of Illinois TRACC facility. The training sessions will also be broadcast over the internet (using Adobe Connect) at
<http://anl.acrobat.com/transim/>

Argonne
NATIONAL LABORATORY

TRANSIMS
Training Course
June 23-25, 2009
Houston, TX

Location
Houston is acknowledged as the Energy Capital of the World and is one of the new TRANSIMS users.

Location
The training course will be held at the College of Technology, University of Houston (UH) (see maps on reverse side), in room 225, Technology Building. The training sessions will also be broadcast over the Internet (using Adobe Connect) at
<http://anl.acrobat.com/transims/>

The Transportation Research and Center at Argonne National Laboratory course on the regional transportation TRANSIMS. The course is targeted to the TRANSIMS methodology, at theoretical underpinnings as well as application of the code. Participants will understand the general TRACC implementation details, data requirements of the software.

TRANSIMS (short for Transportation Simulation System) is an integrated set of tools developed to conduct regional multimodal transportation system analyses. With the goal of establishing ongoing public resource available community, TRANSIMS is made a Highway Administration under a NASA Open Source Agreement and is therefore readily available to the community.

The software is compatible with regular desktop or server systems, but can also make use of high performance computing systems such as the TRACC cluster, a 512 core Linux system with 240TB of disk space and extremely fast network connections across the United States. This cluster is generally available to researchers in the US transportation community and is currently being used for TRANSIMS traffic simulation, emergency evacuation modeling, computational fluid dynamics for bridge analysis, and structural mechanics codes to determine crashworthiness and structural integrity of highway components and vehicles.

www.tracc.anl.gov

Georgia Tech College of Engineering
School of Civil and Environmental Engineering

TRANSIMS
Training Course
June 17-19, 2008
Atlanta, Georgia

Location
The training course will be held at the DuPage Airport Flight Center in West Chicago where Argonne's TRACC offices are located. The training sessions will be held on the third floor of the flight center at the University of Illinois TRACC facility. The training sessions will also be broadcast over the internet (using Adobe Connect) at
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Argonne
NATIONAL LABORATORY

TRANSIMS
Training Course
January 27-29, 2009
Moreno Valley, CA

Location
The training course will be held at the City of Moreno Valley Conference and Recreation Center (see maps on reverse side), in Alexander Room A. The training sessions will also be broadcast over the Internet (using Adobe Connect) at
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- TRACC is providing training courses on TRANSIMS and other subject areas to the transportation research community in the US

- Training courses are offered approximately 10 times per year in varying locations

- Participation is free, and training courses are broadcast over the Internet to reach additional users

- TRACC is holding additional training sessions on emerging capabilities through the Internet

- The goal is to build a strong community of expertise

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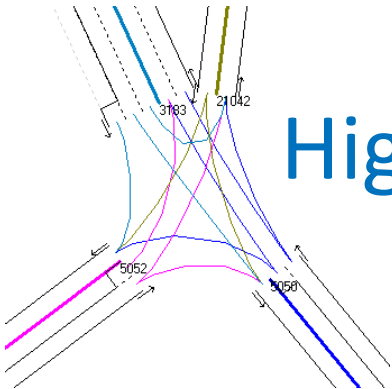
Supported TRANSIMS Models (selected)



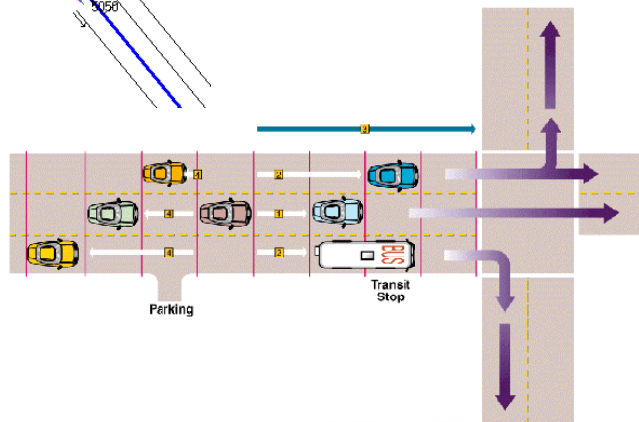
TRANSIMS at a Glance

- **Activity-based** large regional models, e.g. Chicago, Washington DC, Atlanta
- **Microscopic** simulation of passenger and transit vehicles
- **Open source** allows for the integration with dispersion models, infrastructure databases, communication, etc
- Originally developed by **Los Alamos** and now developed as an open source tool set

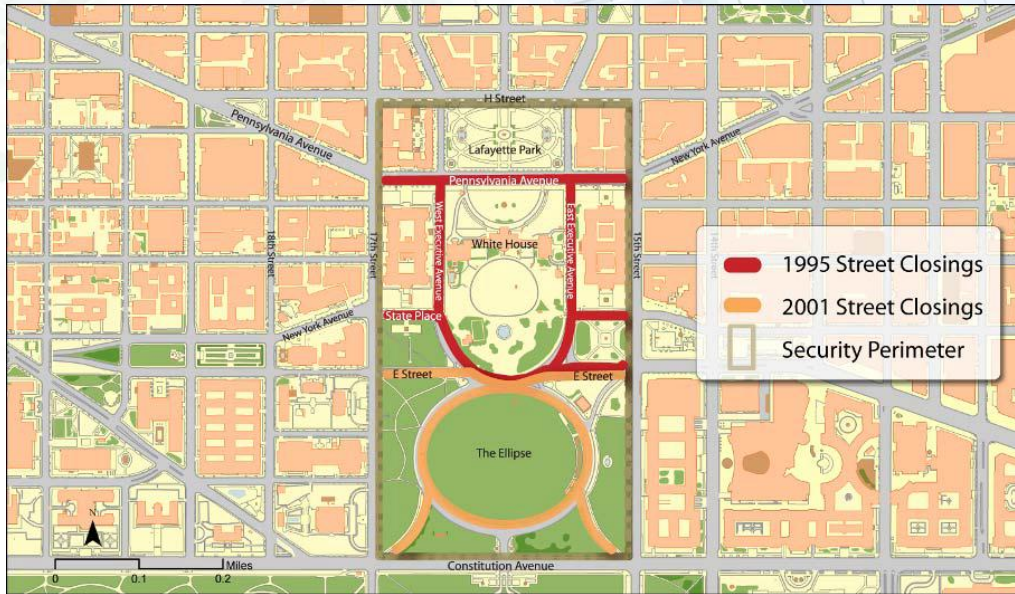
High Fidelity



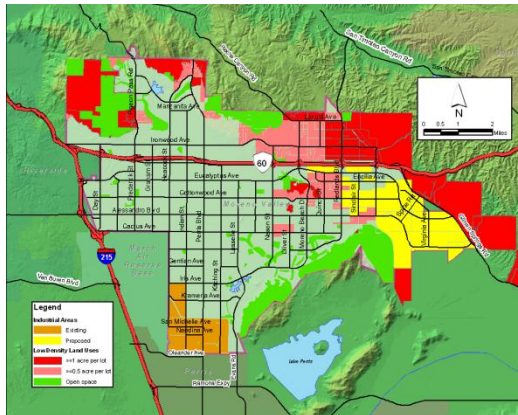
Multi Modal



Typical Applications Applications



Congestion Mitigation (FHWA, AECOM)



Land-Use Change (FHWA, City of Moreno Valley)



Hurricane Evacuation
(Louisiana State University)



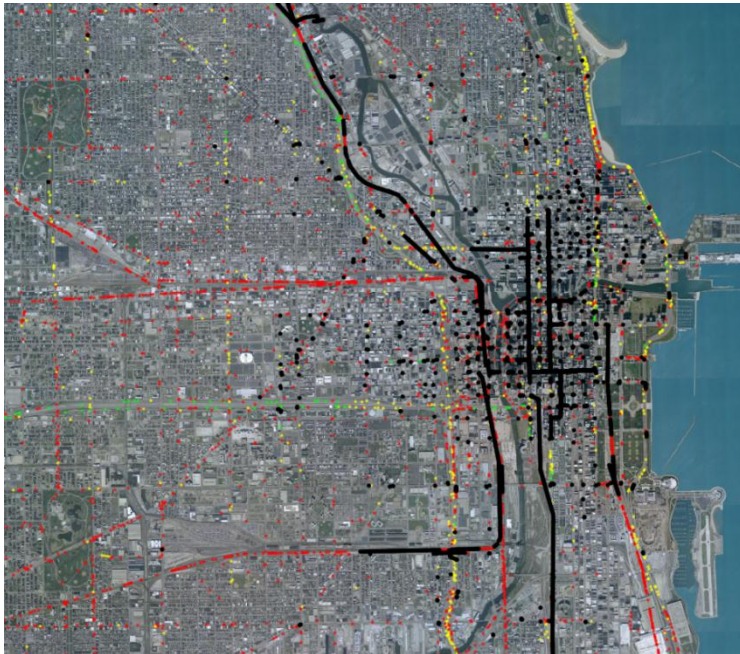
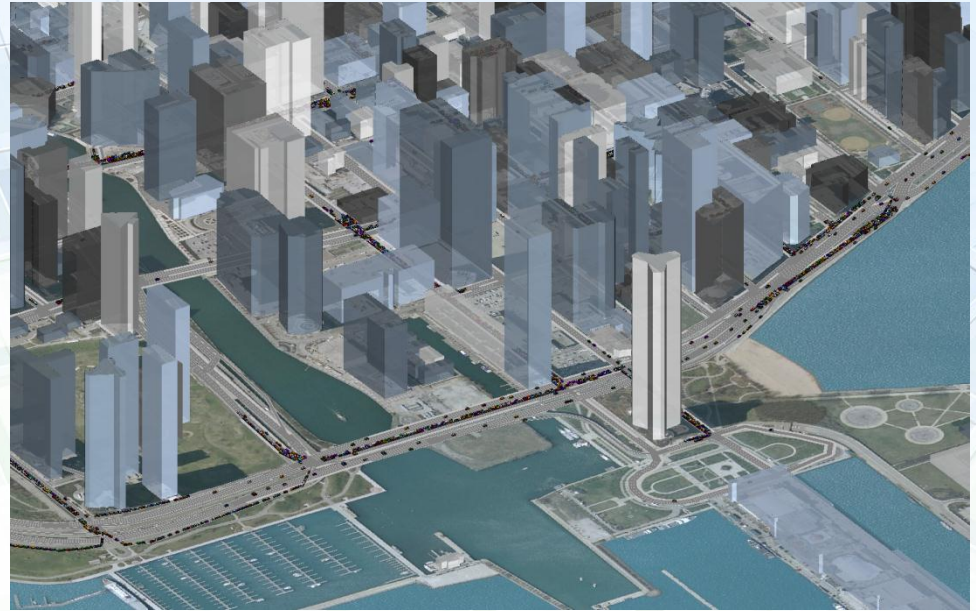
Nuclear Power Plants Evacuation Plans
(NRC, AECOM)

TRANSIMS at TRACC

- Development of tools and methodologies to support a faster and more reliable modeling process
 - **Parallelization** and coordination of simultaneous execution of partitioned data sets
 - Adaptation of TRANSIMS to run effectively **on high performance computing** platforms
 - Development of high level tools such as network editors and **TRANSIMS Studio**
 - High performance **visualization** to aid in developing and debugging large complex transportation system models
 - **Training classes** to support new and advanced TRANSIMS users
- Development of a Chicago TRANSIMS model
 - Used as the basis for TRANSIMS **software and methodology improvements**
 - Model is largely based on data and previous models from **CMAP**
 - The model is being shared with other research teams, e.g. IIT/CDOT
- Focus on transportation system aspects of emergency evacuations
 - Funding by IDOT provided initial resources to build the regional Chicago model
 - Funding by OEMC (City of Chicago) supported the development of RTSTEP

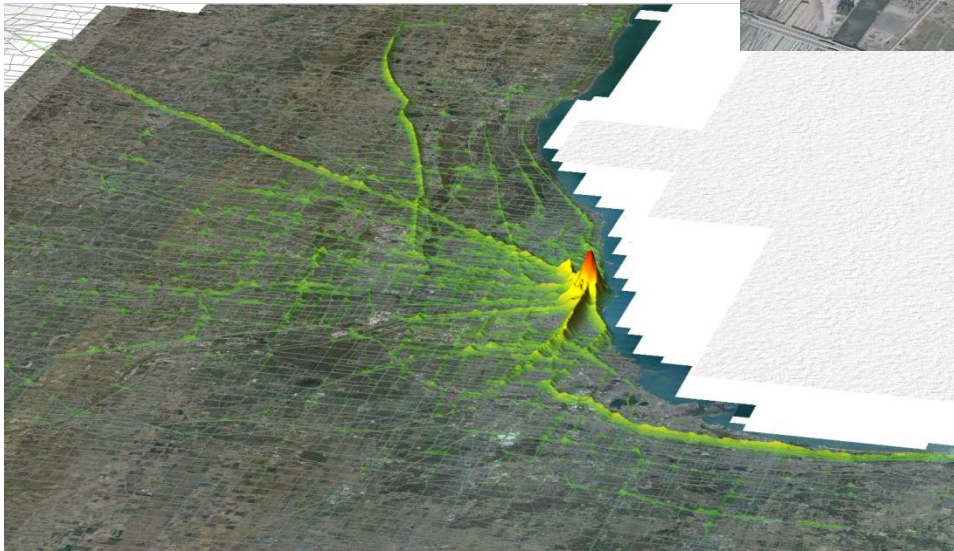
TRANSIMS Visualization

- 3-d plus time navigation
- Regional area to street level detail zooming capability
- Targets model developers and the model debugging process



TRANSIMS Visualization

- Effective visualization allows the human brain to detect simulation flaws or actual congestion problems
- Heat plots for larger areas and street level bar graphs for higher resolution areas allow for understanding dynamic effects causing bottlenecks

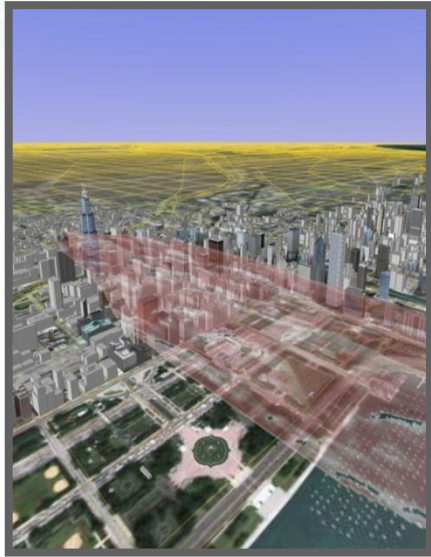


Modeling and Simulation of an Emergency Evacuation Scenario for the Chicago Metropolitan Area

2007-2009



Modeling and Simulation of an Emergency Evacuation Scenario for the Chicago Metropolitan Area



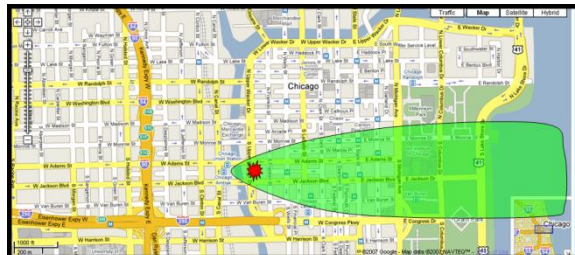
- Model the effects of a no-notice event on the multi-modal regional transportation system in the Chicago metropolitan area
- The chosen scenario postulates a radioactive release following an explosion at the base of the Sears Tower
- This project deals with the dynamic effect on the transportation system

- ~10,000 square miles
- 40,000 links
- 14,000 intersections
- 9 million residents
- ~26.5 million vehicle trips
- ~1.5 million transit trips
- 500,000 concurrent drivers

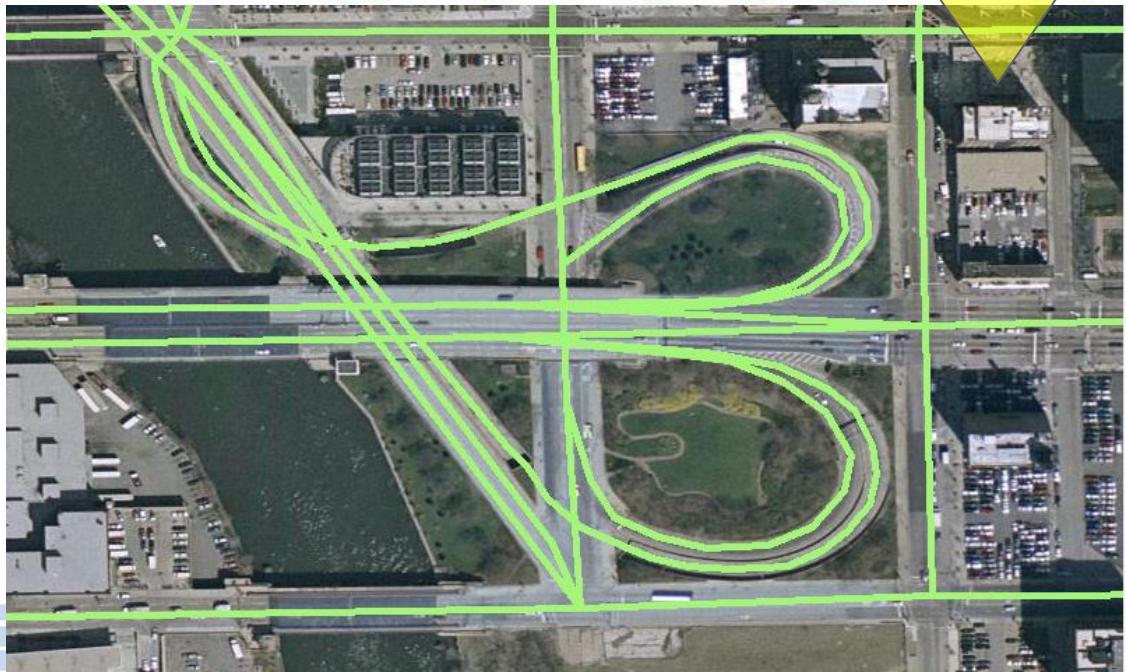
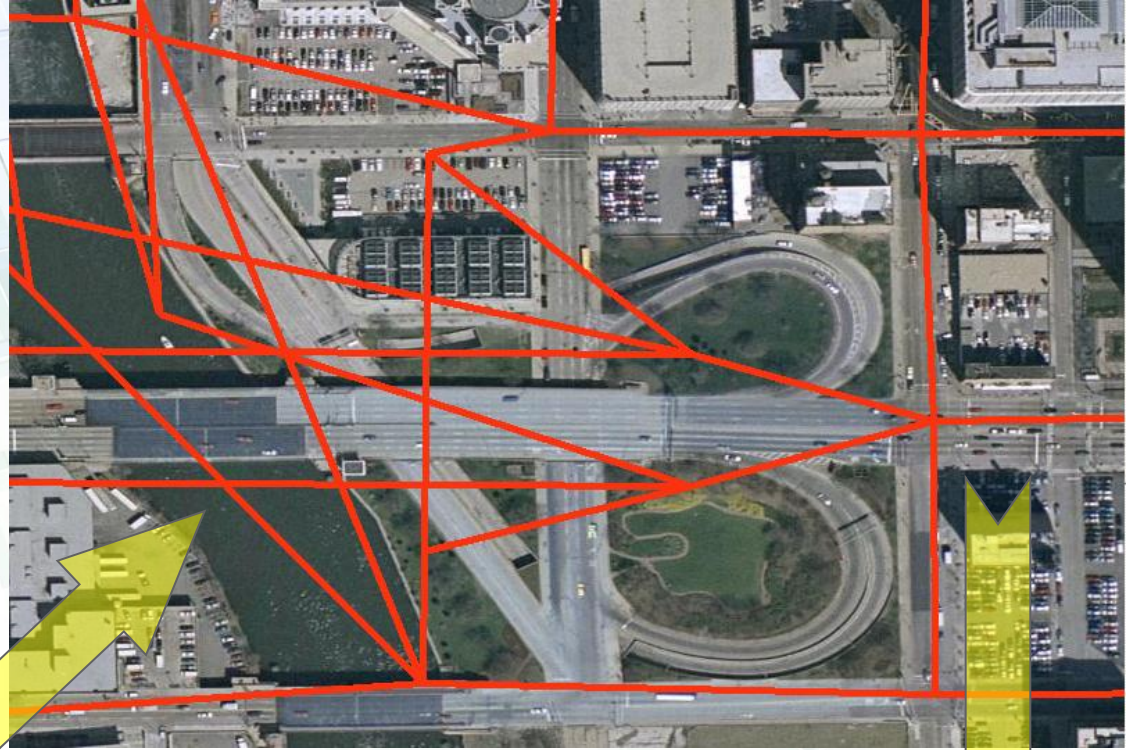


Chicago Normal Day Model (US DOT)

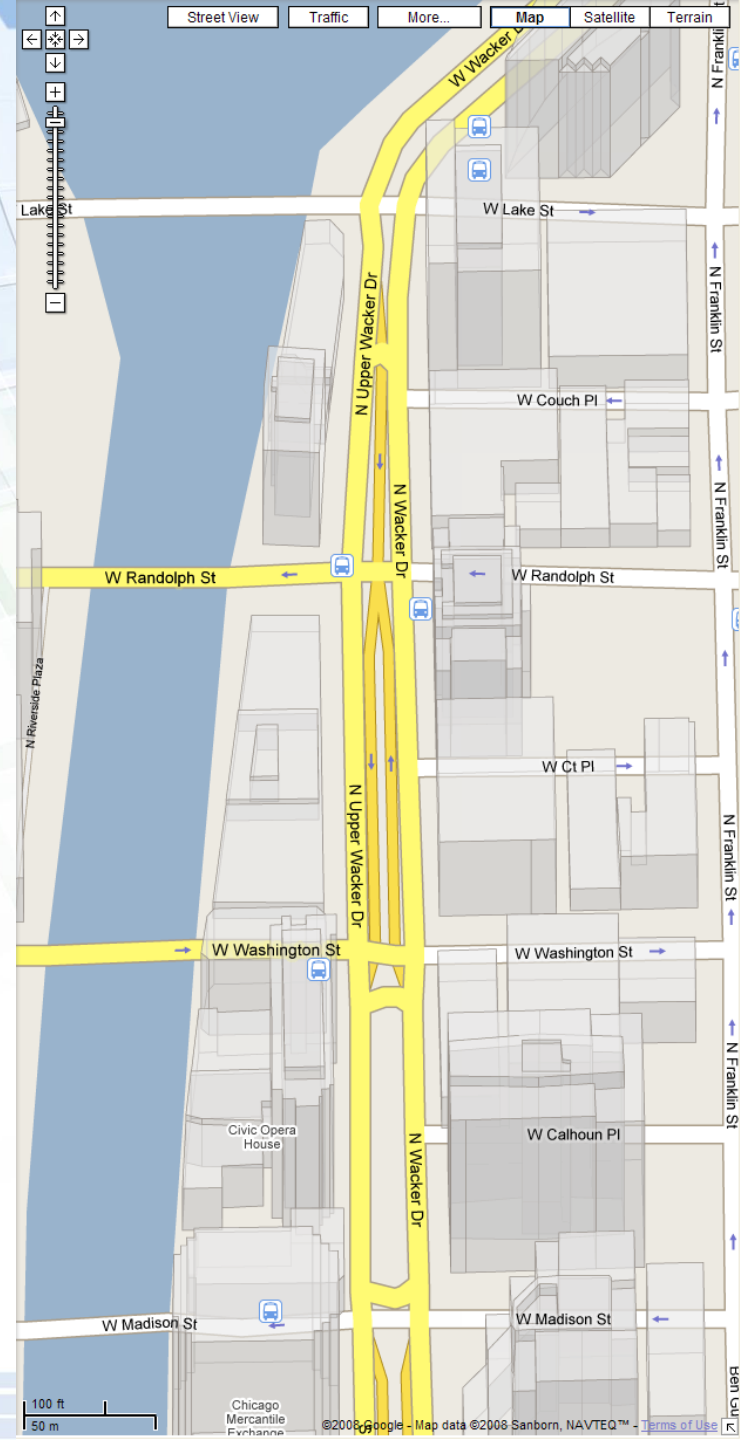
Chicago Downtown Evacuation (IDOT, IEMA, US DOT, ITTF)



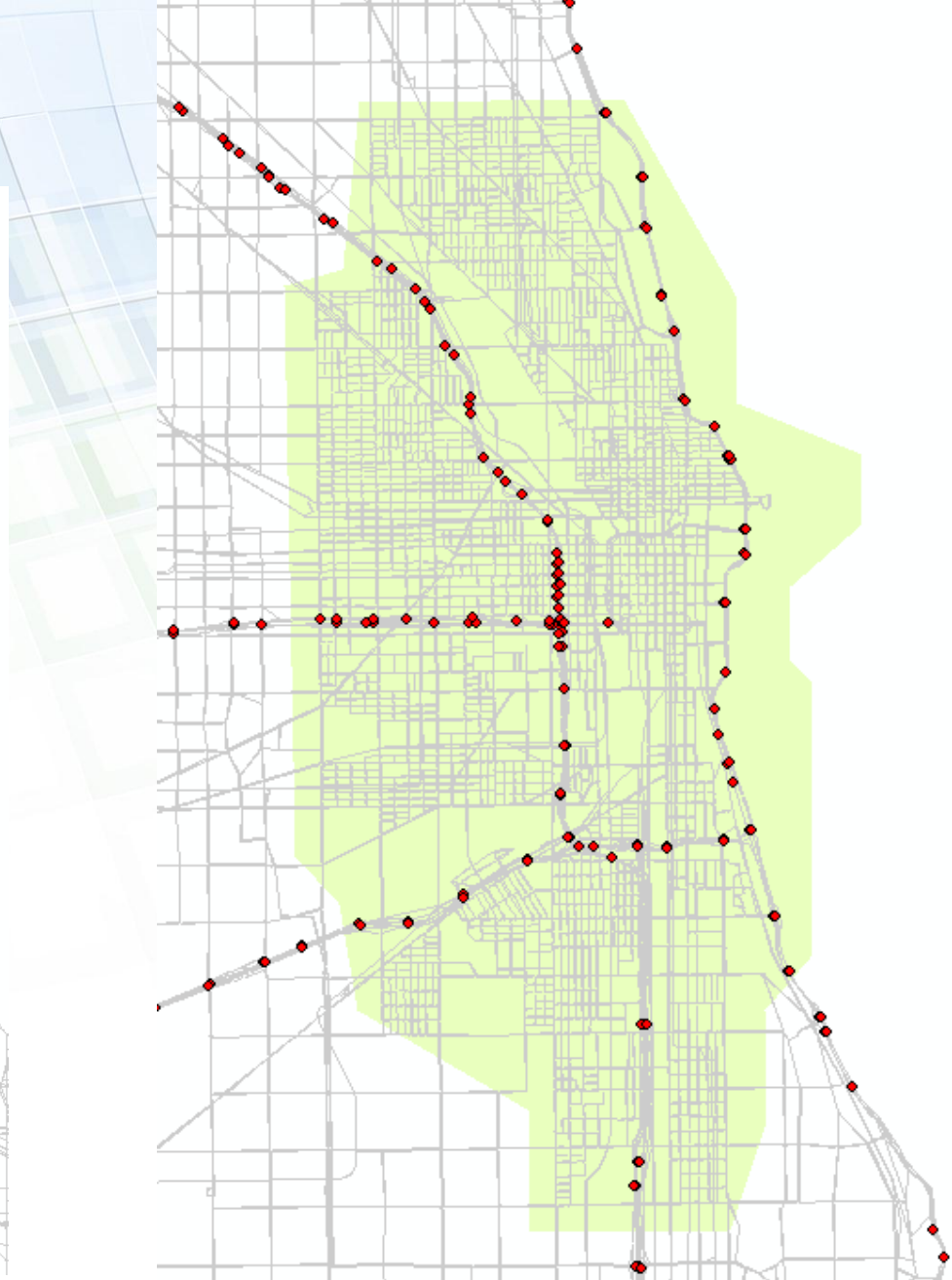
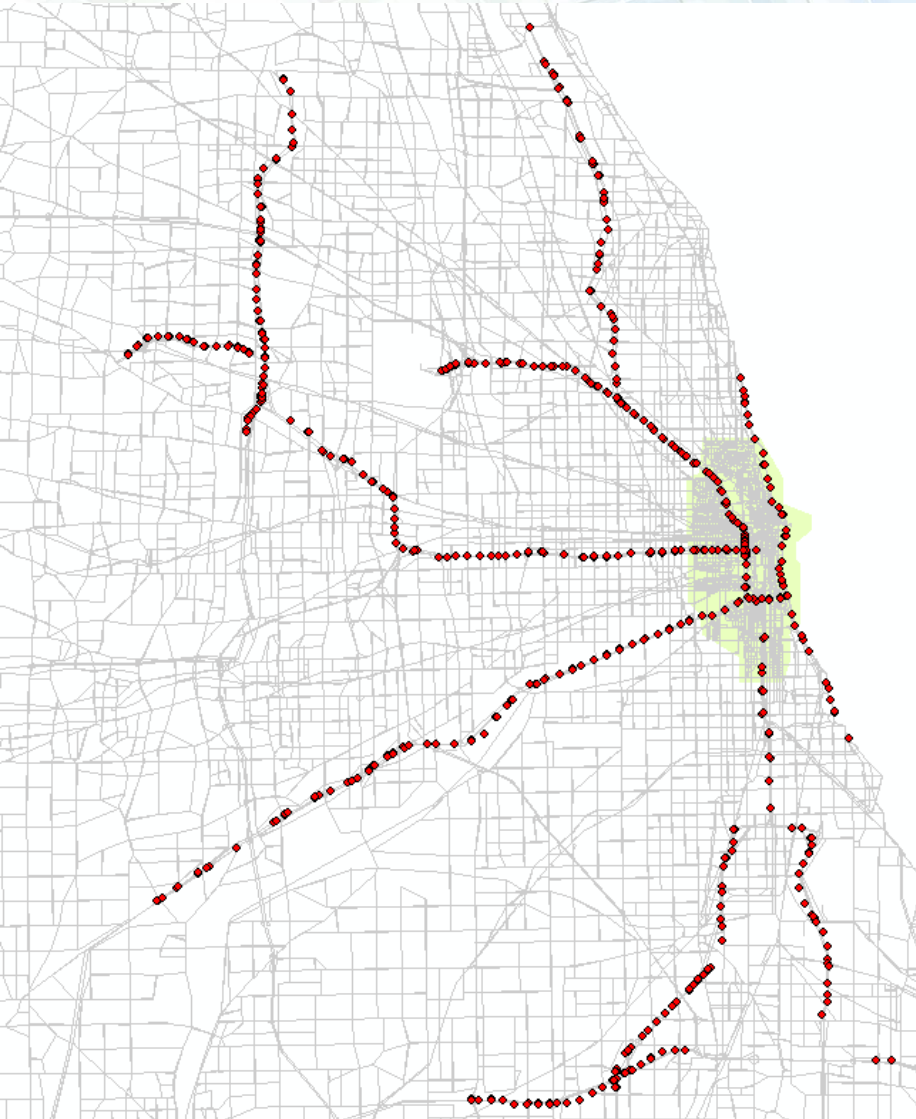
Network Editing



Google Maps and Street View

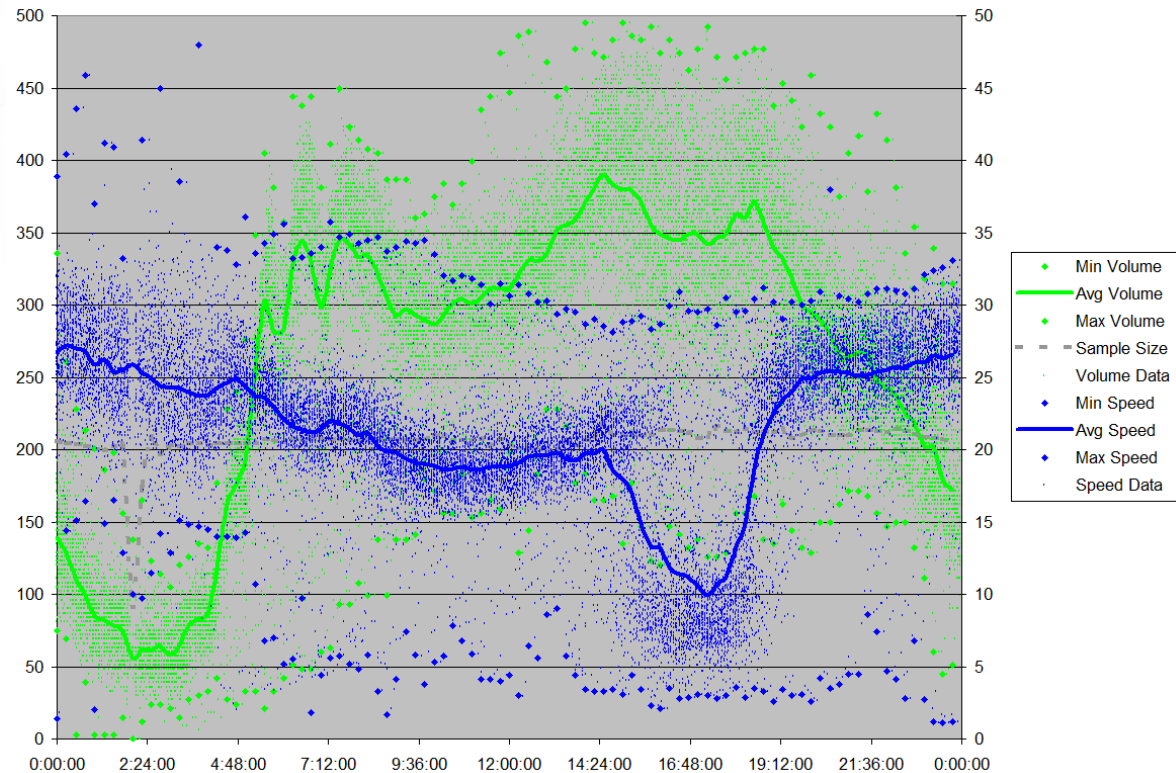


GCM Sensor Data



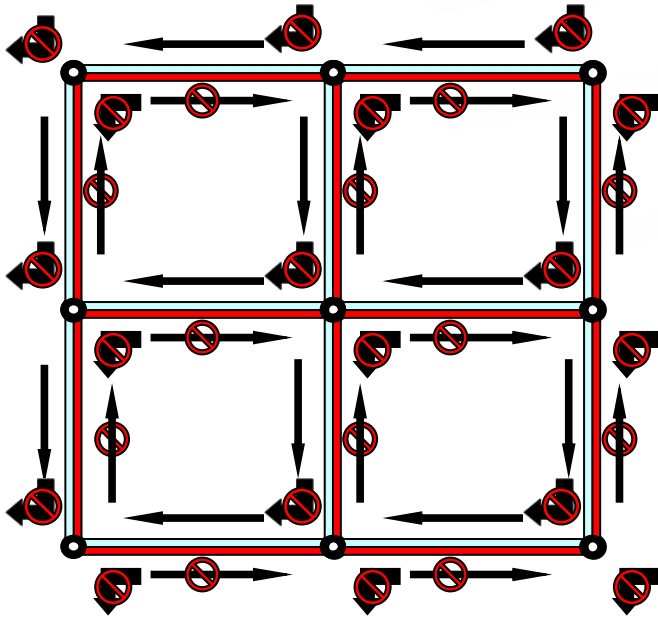
TRANSIMS Validation and Forecasting

- GCM sensor data has been captured for several years
- ~750 active sensors
- 5 minute volumes and speeds
- Valuable for future work in the Chicago area, e.g. dynamic traffic assignment other than TRANSIMS
- Data mining for special events and other potential validation of emergency conditions



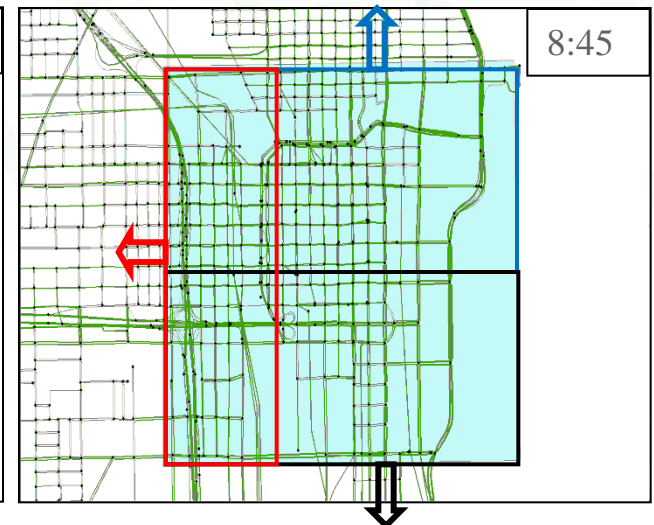
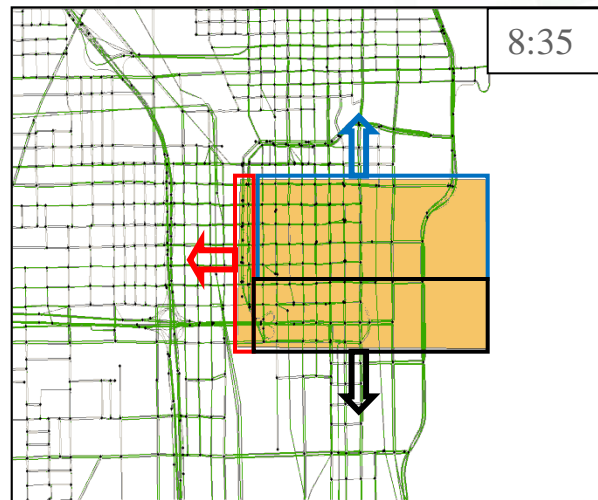
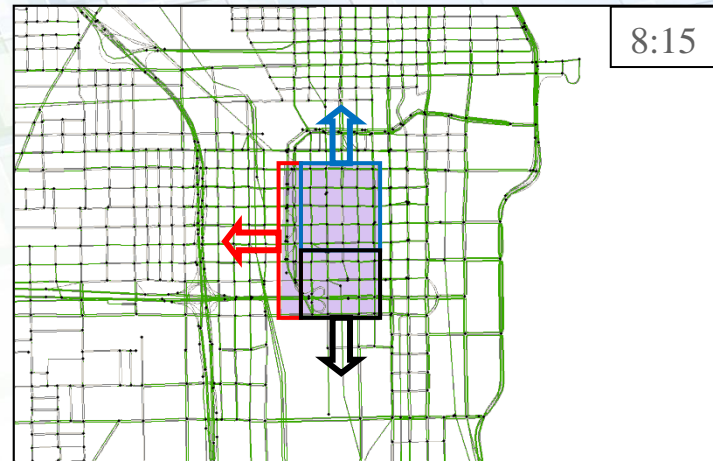
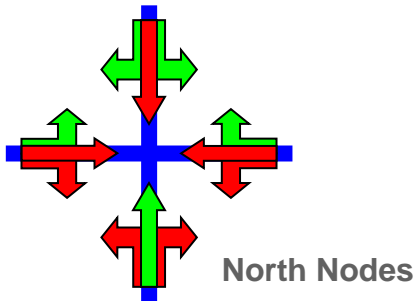
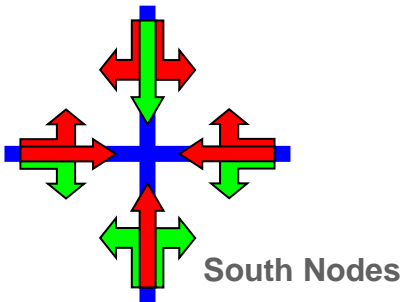
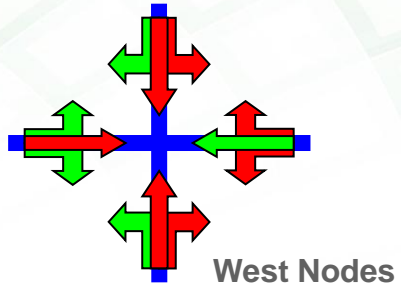
Traffic Rerouting

- Traffic rerouted to resolve congestion, redirect traffic, or allow access by emergency vehicles
- Method based on Modification of
 - Turn_prohibition table
 - Lane_use table



Traffic Rerouting: Dense Urban Areas

- Modify Turn_Prohibition Table



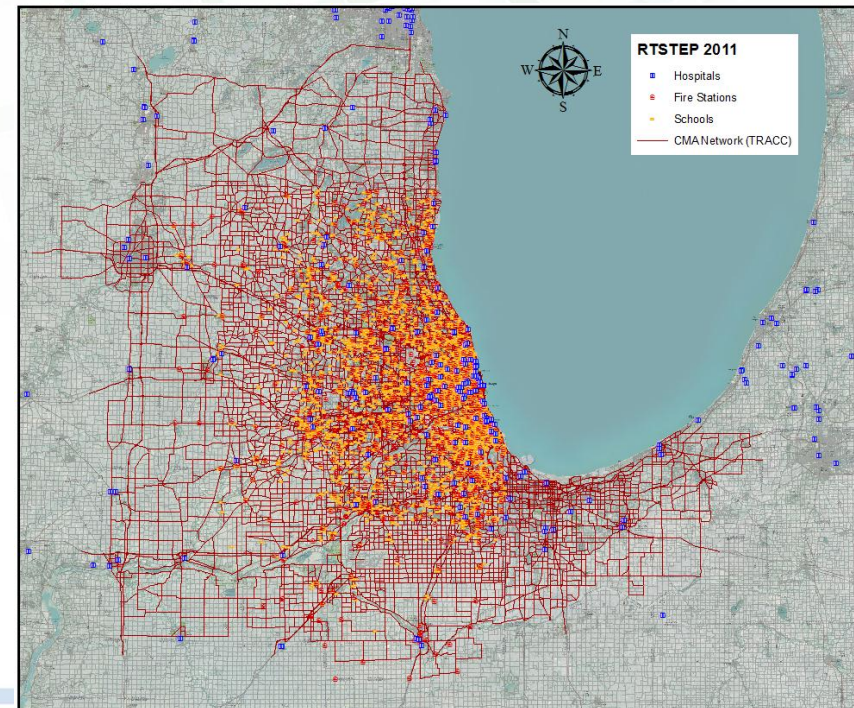
RTSTEP - A Regional Transportation Simulation Tool for Evacuation Planning

2010-2011



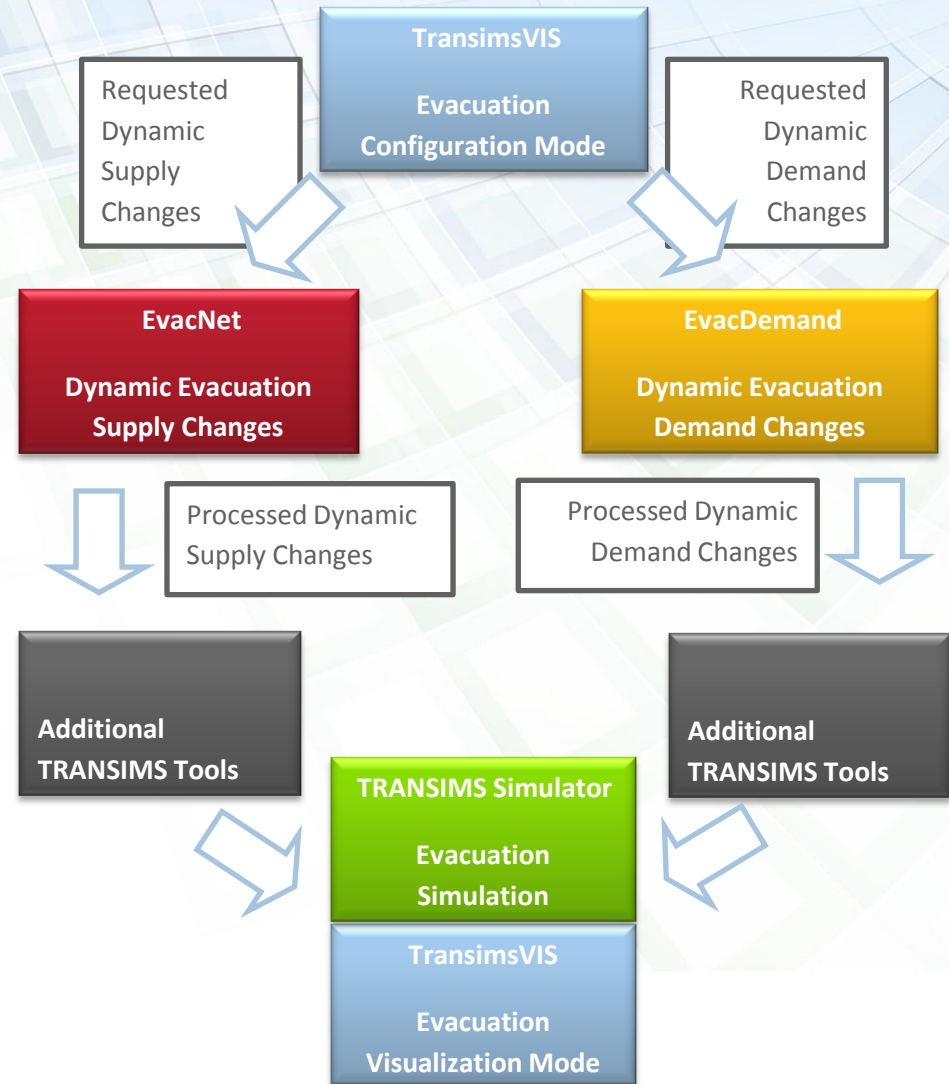
Regional Transportation Simulation Tool for Evacuation Planning (RTSTEP)

- **Decision support tool** for evacuation planning that can be used while establishing emergency response plans constrained by the transportation system
- Analyze the effectiveness of emergency response strategies that modify the transportation system and disseminate traveler information
 - Emergency evacuation traffic
 - Escape routes
 - Routes for incoming emergency responders
 - Simulate the impact of destination, mode, and route choice decisions on transportation system performance



Regional Transportation Simulation Tool for Evacuation Planning (RTSTEP)

- This project was sponsored by DHS/FEMA under the RCPG (Regional Catastrophic Preparedness Grant)
- Supervised by OEMC (Yilmaz Halac, Office of Emergency management and Communications in Chicago)
- Project aimed at developing a tool that can be utilized to configure, simulate, and visualize regional evacuations for the Chicago Metropolitan Area
- TRACC partnered with AECOM, Northern Illinois University, the Illinois Institute of Technology and the Chicago Metropolitan Area for Planning



The RTSTEP Team



AECOM



NORC
at the UNIVERSITY of CHICAGO



CITY OF CHICAGO
DEMIC
EMERGENCY MANAGEMENT & COMMUNICATIONS

Normal Day Model
Soft Development
Student Assistants

Social Science
Research



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Transportation Research and
Analysis Computing Center

GIS Data
Feedback
Egress Models



ILLINOIS INSTITUTE
OF TECHNOLOGY

Network Data
Trip Tables



NORTHERN ILLINOIS
UNIVERSITY



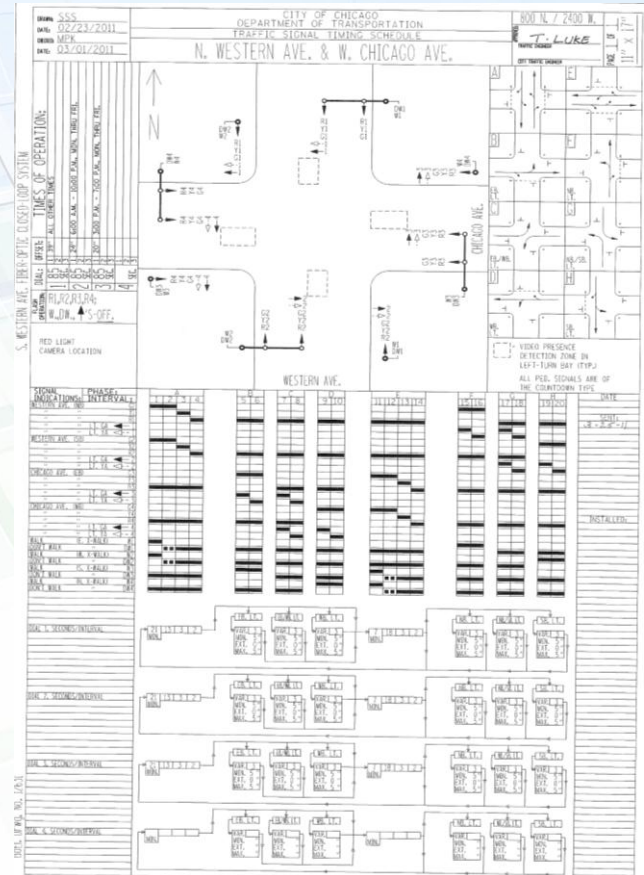
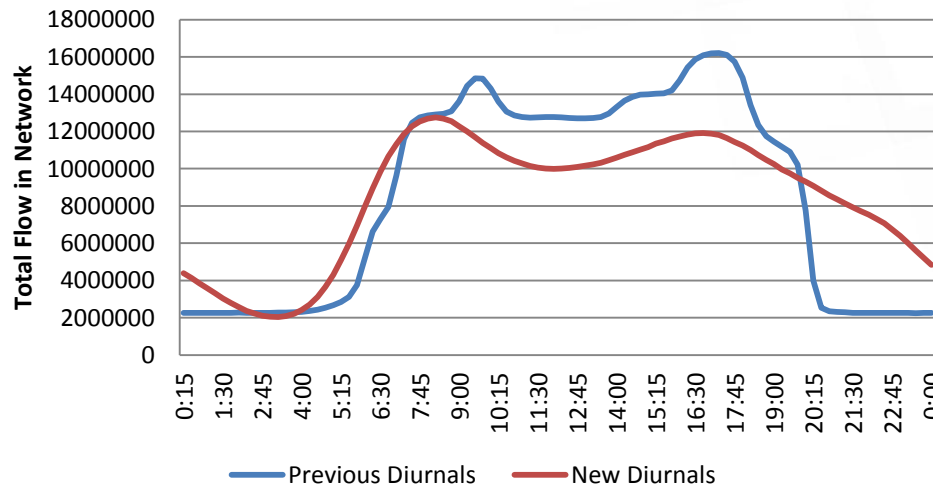
Chicago Metropolitan
Agency for Planning

RTSTEP Data Sources (selected)

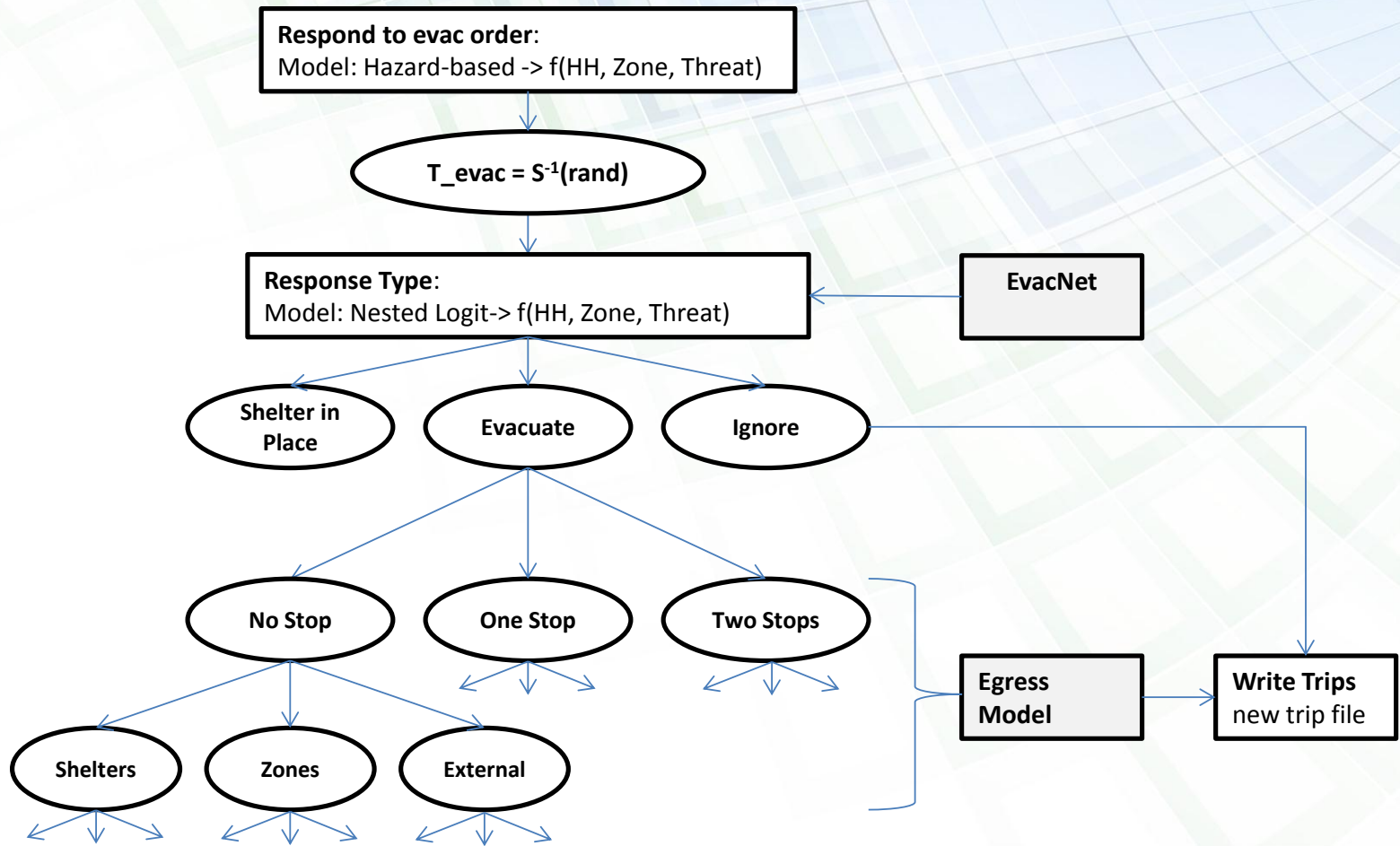


Average day model refinement

- Intersection controls (more than 600 were coded manually)
- Intersection node adjustment (location, connectivity)
- Freeway and Ramp Errors Revision
- Lane Use Update
- Pace Transit Route Editing
- Average Day Plan Update
- Validation
- Assignment parameters calibration



Demand



Intended response survey

- Online intended response survey
- Understand individuals' responses to no-notice evacuation
- 533 responses
- Internet-based Stated Response Survey
- Collaboration with UChicago NORC
- 39K Emails
- Cook and 7 Collar Counties

Table 9.12: Survey Sample Characteristics

Household-level		Person-level			
HH Size	Survey	Census	Age	Survey	Census
1	20%	26%	<15	17%	21%
2	33%	33%	16-25	9%	14%
3	20%	16%	26-35	16%	14%
4+	27%	25%	36-45	13%	14%
			46-55	18%	15%
Income	Survey	Census	56-65	20%	11%
<25	9%	29%	66+	7%	11%
25-50	17%	29%			
50-75	15%	19%	Gender	Survey	Census
75-100	20%	10%	Female	49%	51%
>100	27%	12%	Male	51%	49%
blank	17%	–	blank	1%	–
Tenure	Survey	Census	Employment	Survey	Census
Own	72%	66%	Employed	64%	59%
Rent	25%	34%	Unemployed	7%	8%
blank	3%	–	Not in labor force	29%	32%
Children	Survey	Census	Education	Survey	Census
Yes	32%	36%	HS or less	14%	39%
No	68%	64%	Some College	25%	21%
			Associate / Bachelor	29%	28%
Total Sample Size			Graduate / Prof.	32%	13%
HH	205		blank	1%	–
			Total Sample Size		
			Adult	427	
			Child	106	

Auld, Sokolov, Fontes, Batista “Internet-based stated response survey for no-notice emergency evacuations” in Transportation Letters: The International Journal of Transportation Research, vol. 4, issue 1, January 2012.

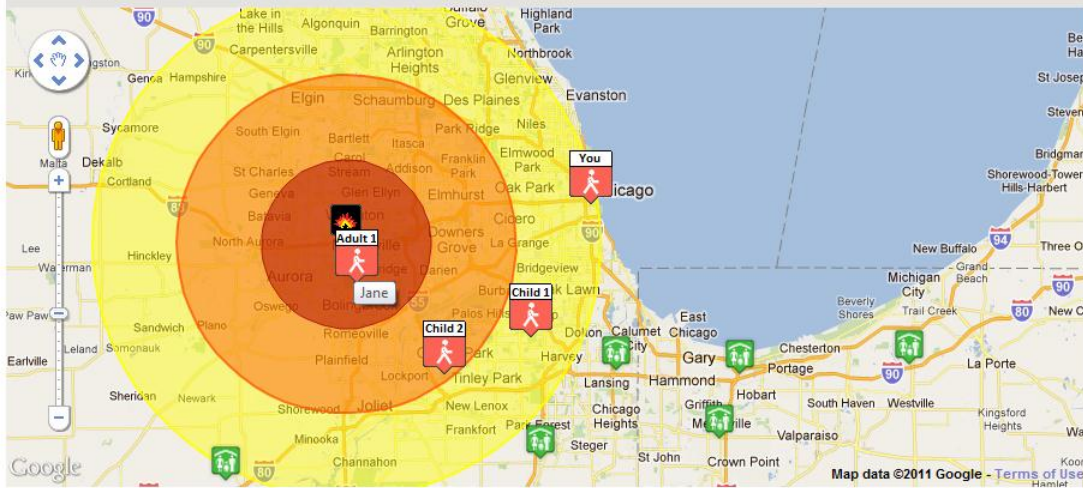
Survey Interface

SCENARIO 1 DESCRIPTION:

An emergency event has occurred at 7PM within 10 miles of Jane. Government authorities have determined that there is **high risks** present to individuals in the area and have **ordered that individuals evacuate immediately**. Authorities have set up evacuation shelters as shown.

At this time you and your other household members are at the locations shown below and you have **NO ACCESS** to a vehicle.

Considering the current locations of you (and members of your household) and your knowledge of the event, please answer the following questions describing how you would respond.



Emergency Hazard Level:

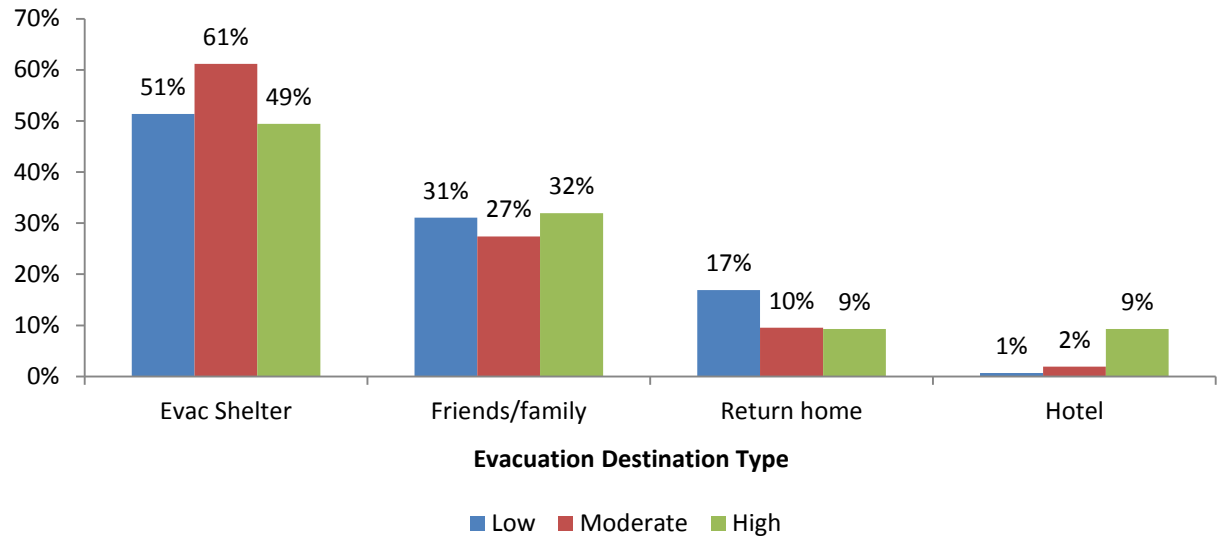
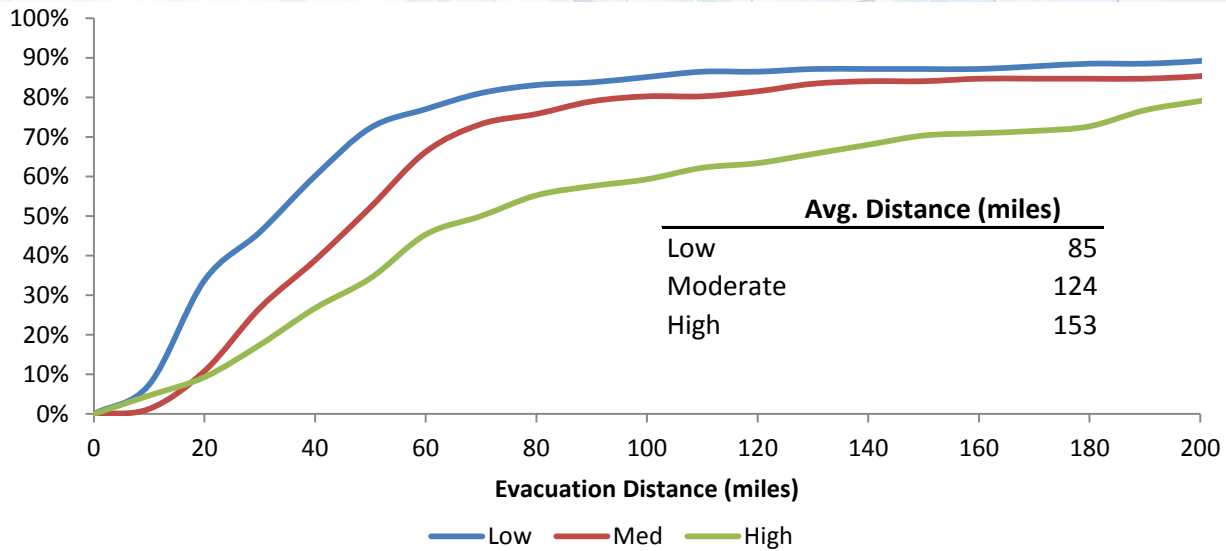


Scenario 1 Response:

Considering the scenario presented above where the government has **ordered that individuals evacuate**, how likely would you be to:

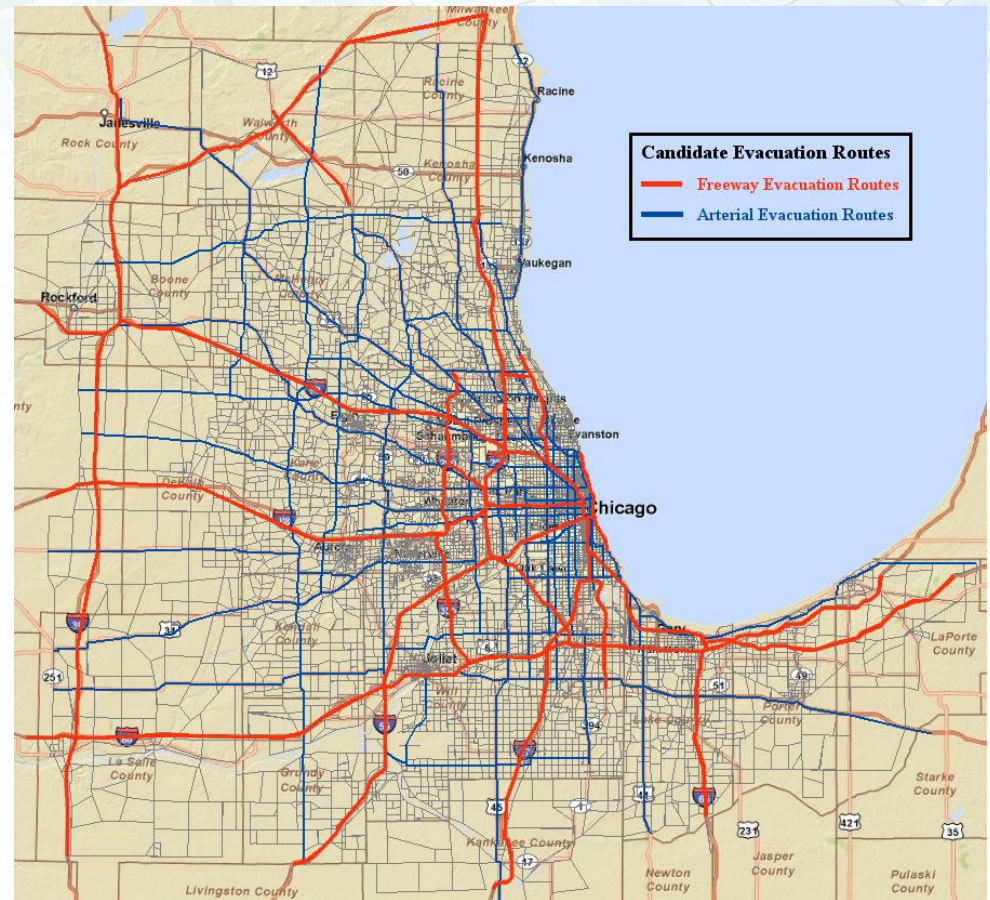
	Very Unlikely		Neutral		Very Likely
Go about your day as usual	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Stay where you are and seek shelter	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Make additional trips and / or evacuate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
Evacuate if you heard others were evacuating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Evacuate if people near you were evacuating	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

Survey Results

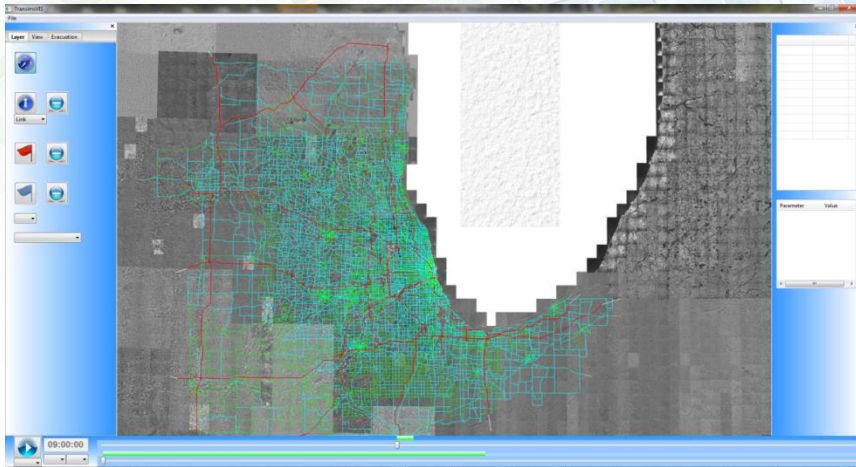


Evacuation Routes

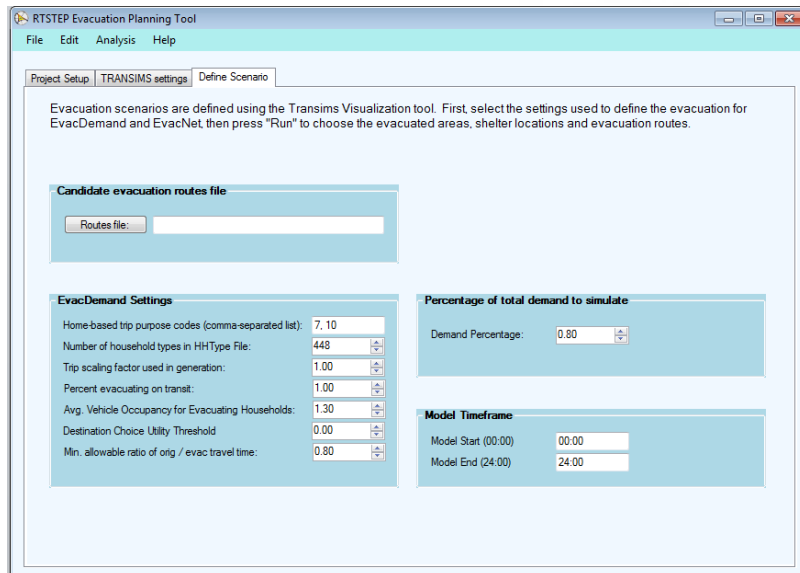
- A set of routes were obtained from CDOT
- The set was refined and extended to cover the entire region
- TRACC developed a tool that allows the implementation of control strategies for intersections



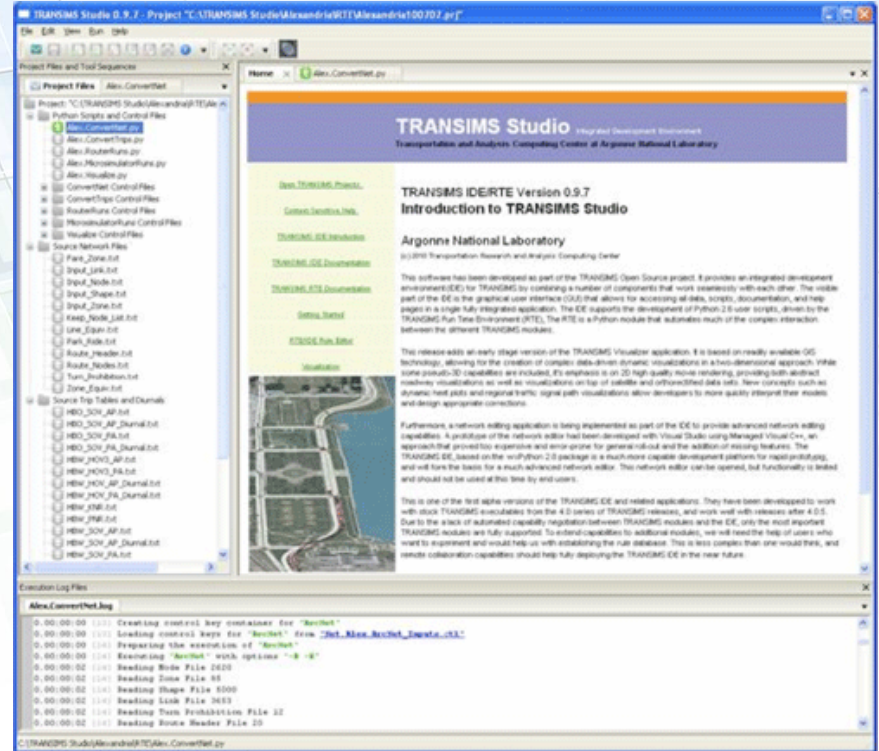
User Interface



Visualization at TransimsVIS



Evacuation Setup at RTSTEP



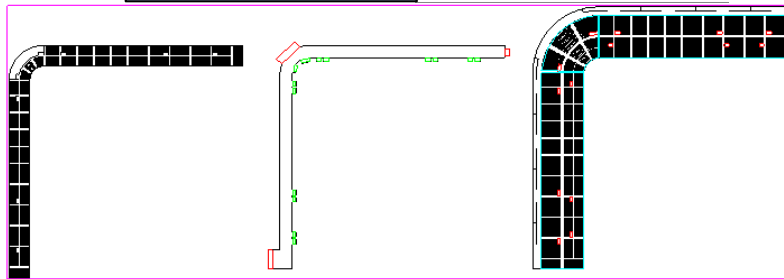
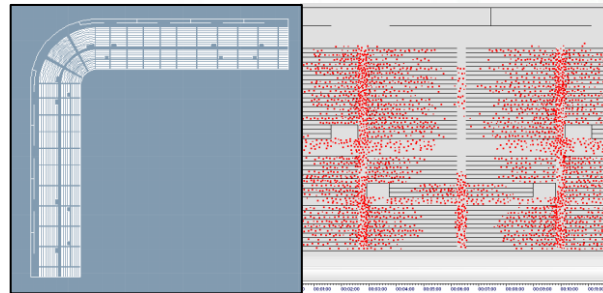
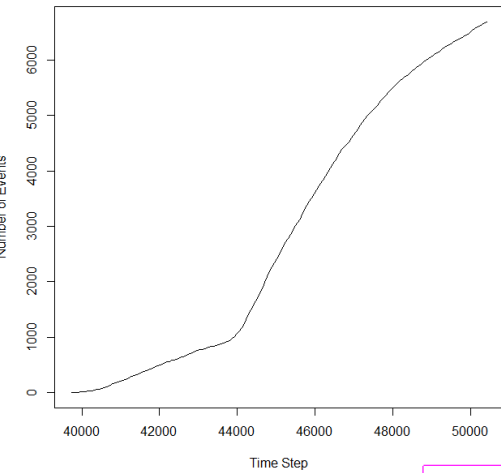
Normal Day Run setup at TRANSIMS Studio



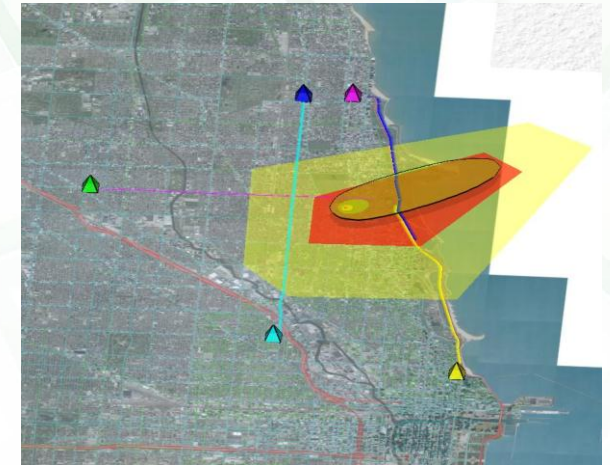
Case Studies

- Urban Area
- Rural Area
- Egress Model

Cummulative Shelter Utilization



WRIGLEY FIELD CASE STUDY				
Evacuation Responses	No evacuation planning		With evacuation planning	
	Count	%	Count	%
Return home	467	0.4%	467	0.4%
Ignore evacuation	4,078	3.7%	4,204	3.9%
Shelter in place	29,588	27.1%	29,342	26.9%
Evacuate to shelter	-	-	45,864	42.0%
Evacuate - leave region	12,185	11.2%	12,192	11.2%
Evacuate - Go to friends/family/hotel	62,821	57.6%	17,070	15.6%
Total population @ start	109,139	100.0%	109,139	100.0%
Other impacted individuals				
Diverted trips, due to evacuation	160,022		160,022	
Cancelled trips	274,770		274,380	





Questions?

For more information,
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