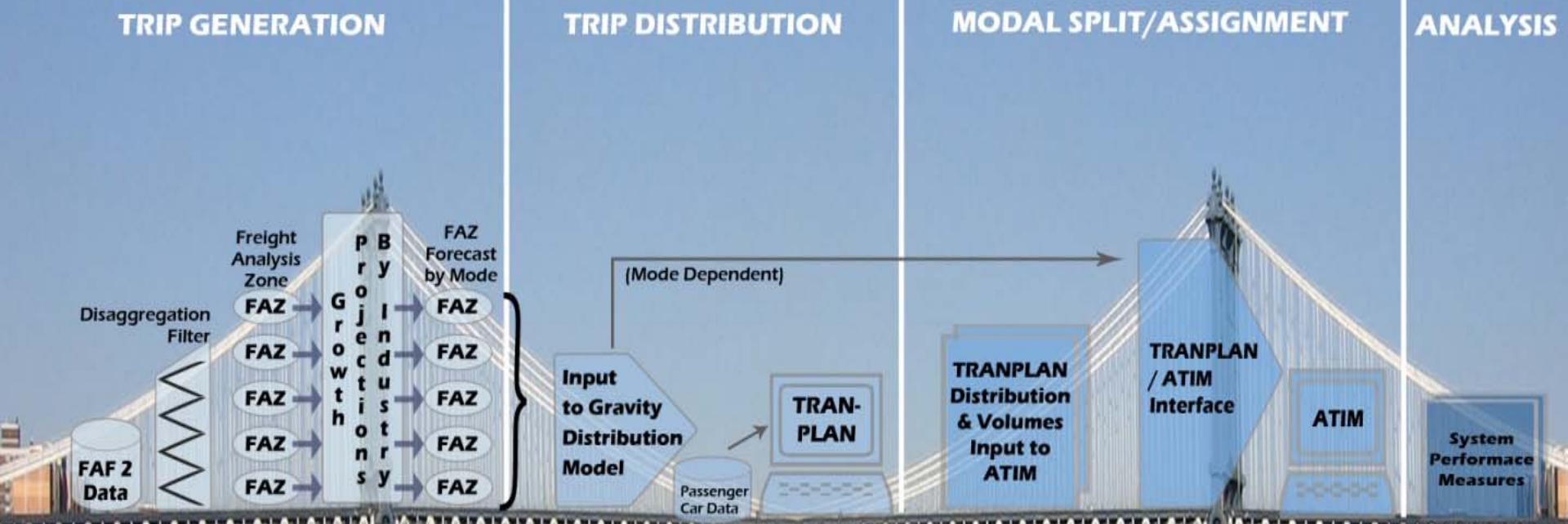
Transportation Infrastructure in Alabama
Bridging the Data & Information Gap



Presented to the Federal Transit Administration
Office of Research, Demonstration and Innovation

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Washington, D.C.

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Alabama Overview

State Business Climate Rankings 2004 – 2007

Ranking Organization	2004	2005	2006	2007
Pollina Corporate Top Ten Pro-Business States	4	5	9	8
Small Business and Entrepreneurship Council – Small Business Survival Index	8	8	4	10
Fortune Small Business - 10 Best States for Starting a Business	--	--	3	10
Site Selection Magazine – Business Climate Survey	10	7	8	5

Expansion Management "work force training rankings" Alabama Industrial Development & Training

2000 - #7	**2002 - #4**	**2004 - #1**	**2006 - #1**
2001 - #7	**2003 - #6**	**2005 - #2**	**2007 - #1**

The Reason Foundation Report on System Performance of State Highway Systems

- 29th in overall performance and cost-effectiveness (in 2007 Alabama ranked 43rd overall).
- 29th in urban interstate congestion, with 45.98 percent congested.
- 39th in rural and urban interstate condition.
- 28th in deficient bridges — 24.93 percent of the state's bridges are deemed structurally deficient or functionally obsolete.
- 40th in the nation in fatality rates per 100 million vehicle miles traveled.

Project Tasks

- **Task 1. Development of a Freight Analysis Zones**
  - Develop the methodology for the establishment of Freight Analysis Zones in Alabama.
  - Apply the FAZ methodology to freight in Alabama through the development of various freight flow models using the different zone structures.
  - Perform analysis to compare different FAZ structures to county level freight planning zones to determine the benefits and costs.

- **Task 2. Expansion and Enhancement of the Alabama Transportation Infrastructure Model (ATIM)**
  - Regionalization through tying ATIM and VITS
  - Improve Graphics
  - The application of system performance measures within ATIM
  - Exercise ATIM through running scenarios from other transportation entities
  - The development of a methodology for determining rural time of day percentages
  - Evaluation of Commuter Rail Service in an Alabama MPO

Project Tasks (2)

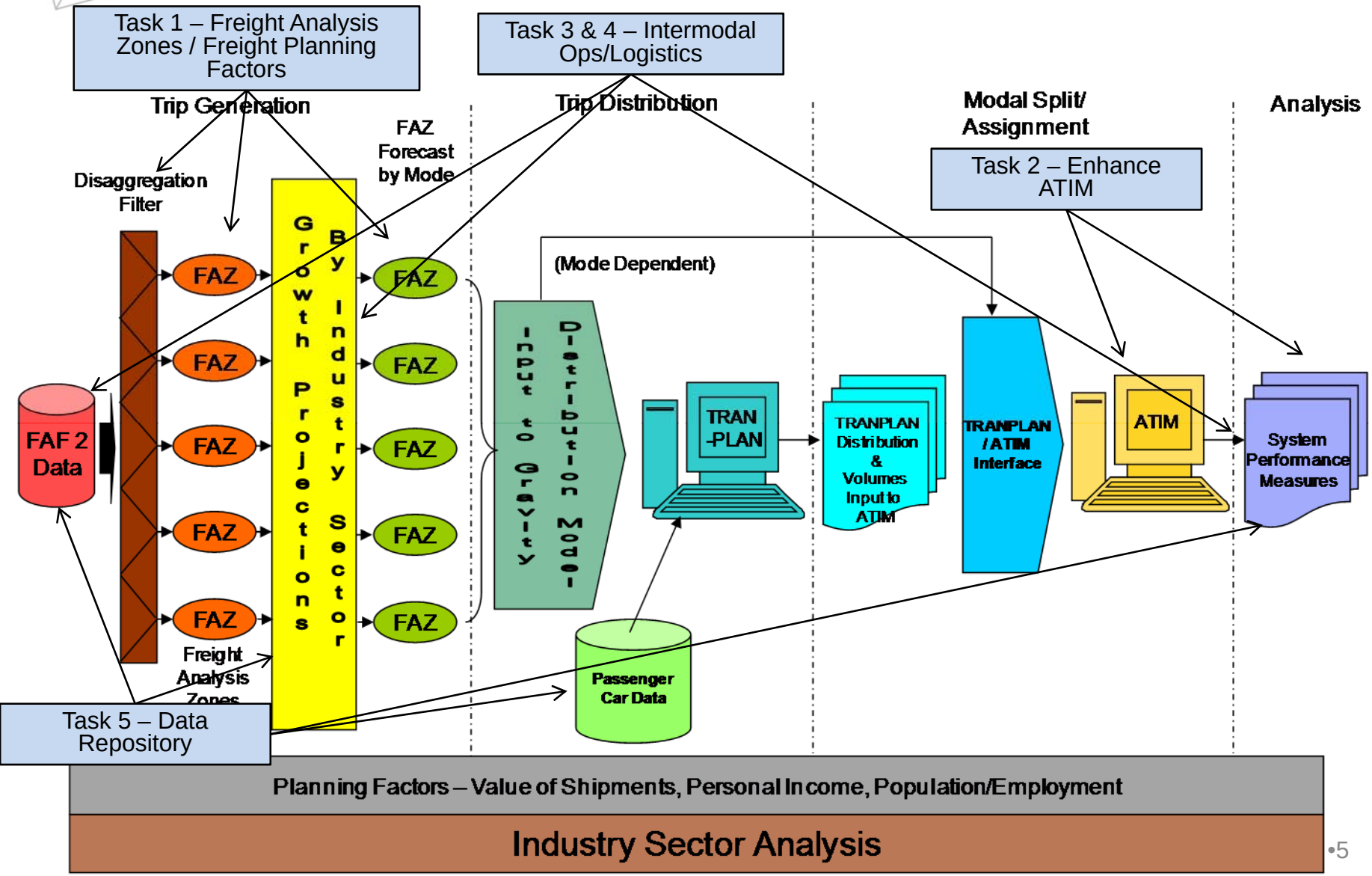
- **Task 3. Modeling intermodal operations using discrete event simulation**

- **Task 4. Continuous improvement in logistics & transportation systems**
  - What are the best performing logistics companies?
  - What are the characteristics of the best performing companies?
  - How do their activities relate to lean thinking?
  - Development of lean logistics & transportation principles.

- **Task 5. Develop the Repository for Transportation Related Data and Information for Alabama and the Tennessee Valley Region**

- **Task 6. Student Research Initiatives**

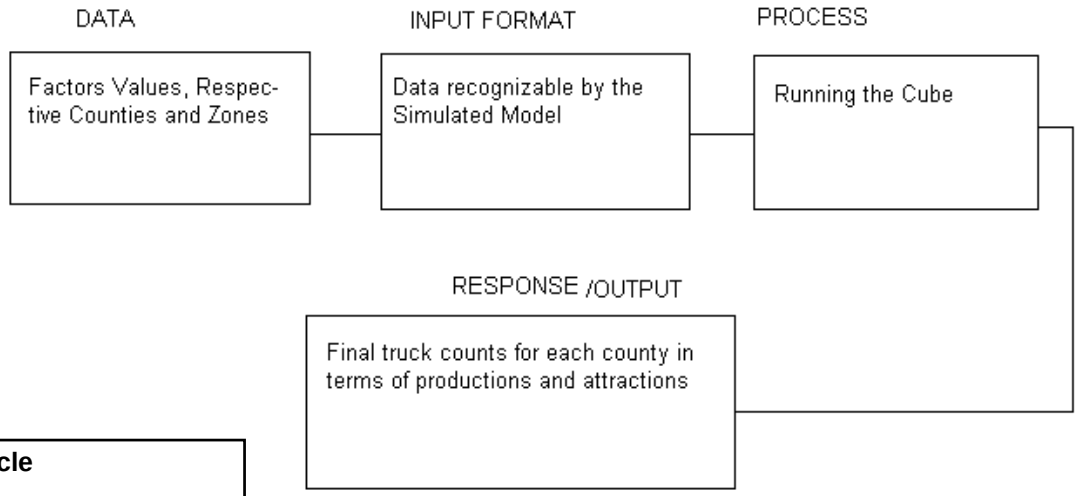
The Freight Planning Framework

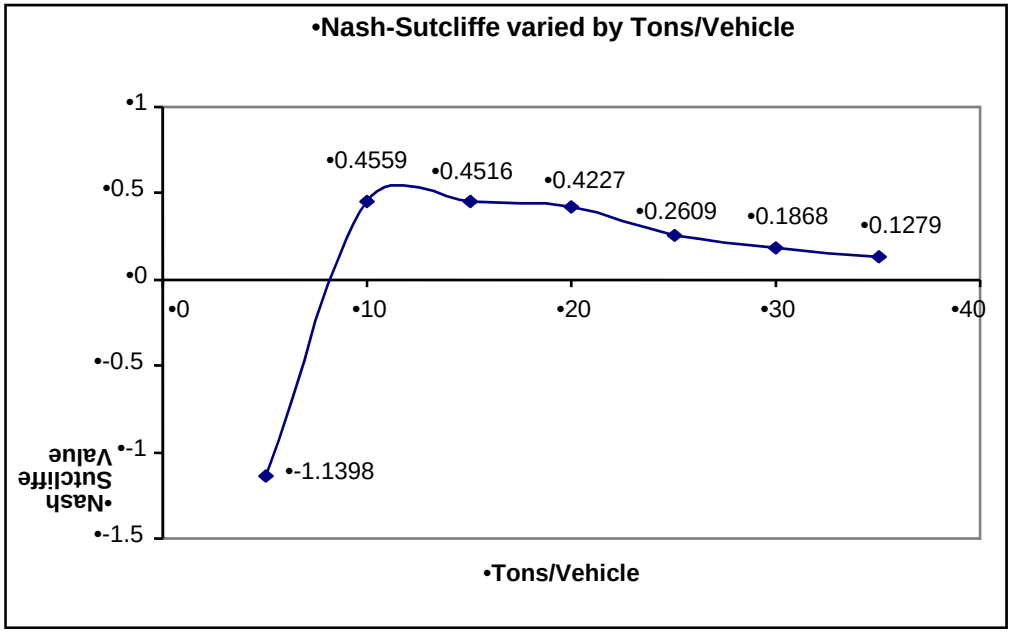


Investigation of Freight Planning Factors

Factors Investigated

- Value of Shipments
- Personal Income
- Employment
- Population





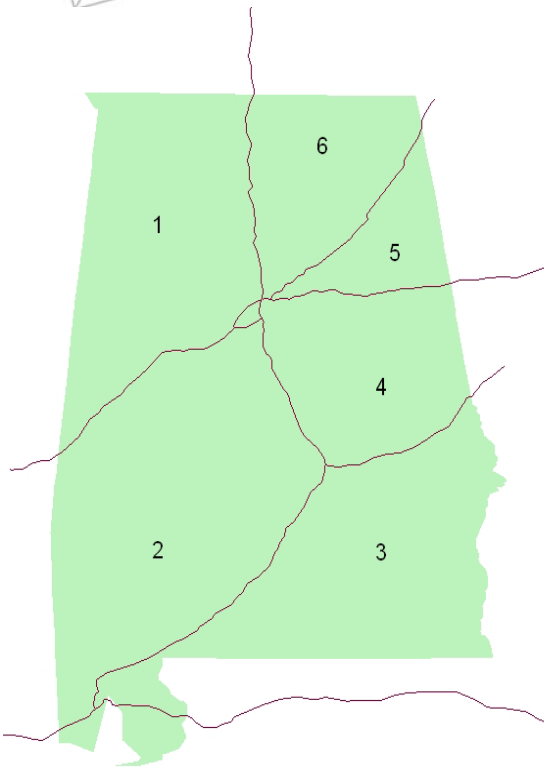
Findings

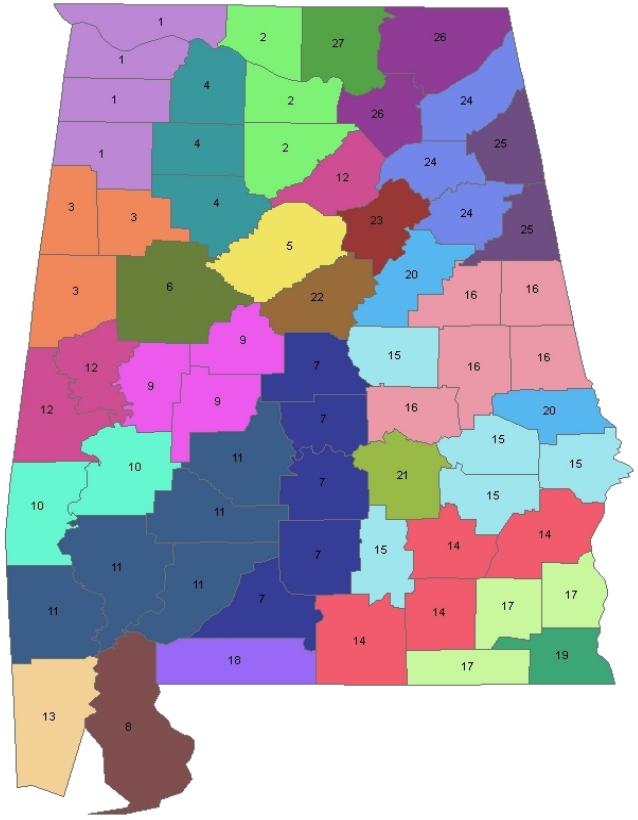
- Value of Shipments and Personal Income provides a better prediction of freight than any other combinations.
- Findings are not conclusive but they are encouraging.

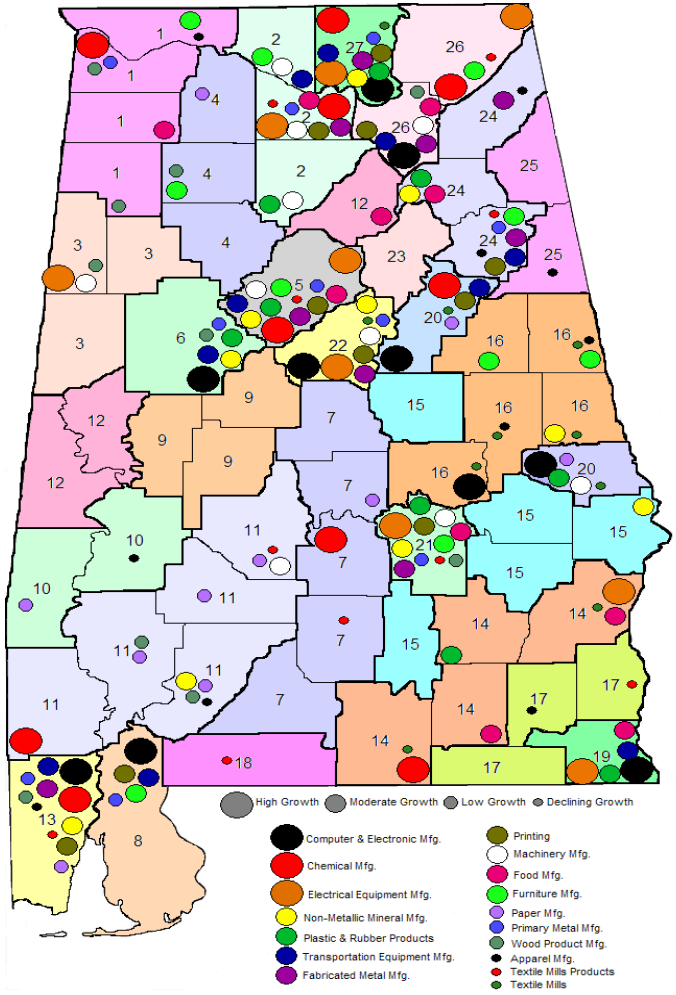
FAZ Approach

- Cluster Analysis of County Data
  - Hierarchical Clustering
    - Wards Method
  - Variables
    - Economic Variables
      - Employment
      - Value of shipments
      - Personal income
    - County Location Data
      - Longitude
      - Latitude
      - Distance from Interstate
- Initial Clusters developed within interstate boundaries
- Clusters revised based on industry type and growth projection

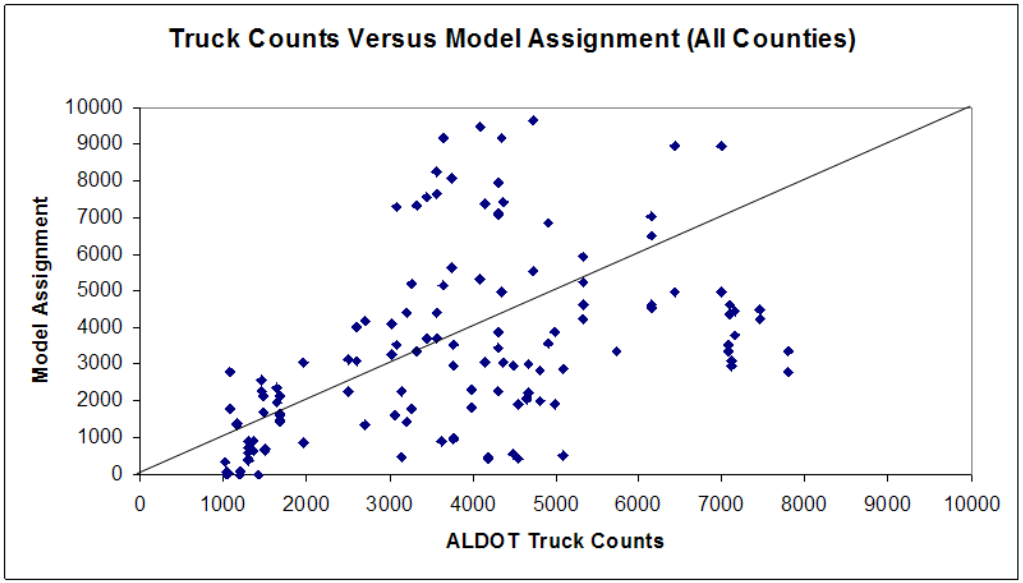
The Development of Freight Analysis Zones





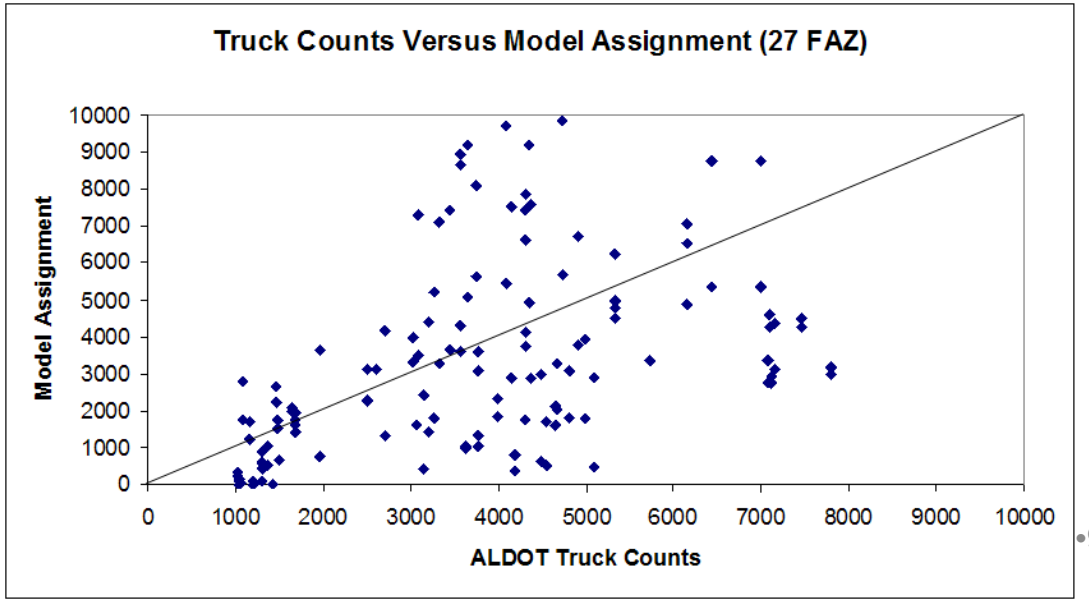


Analysis of FAZ vs Counties



Scatter plot for the 67 County Model

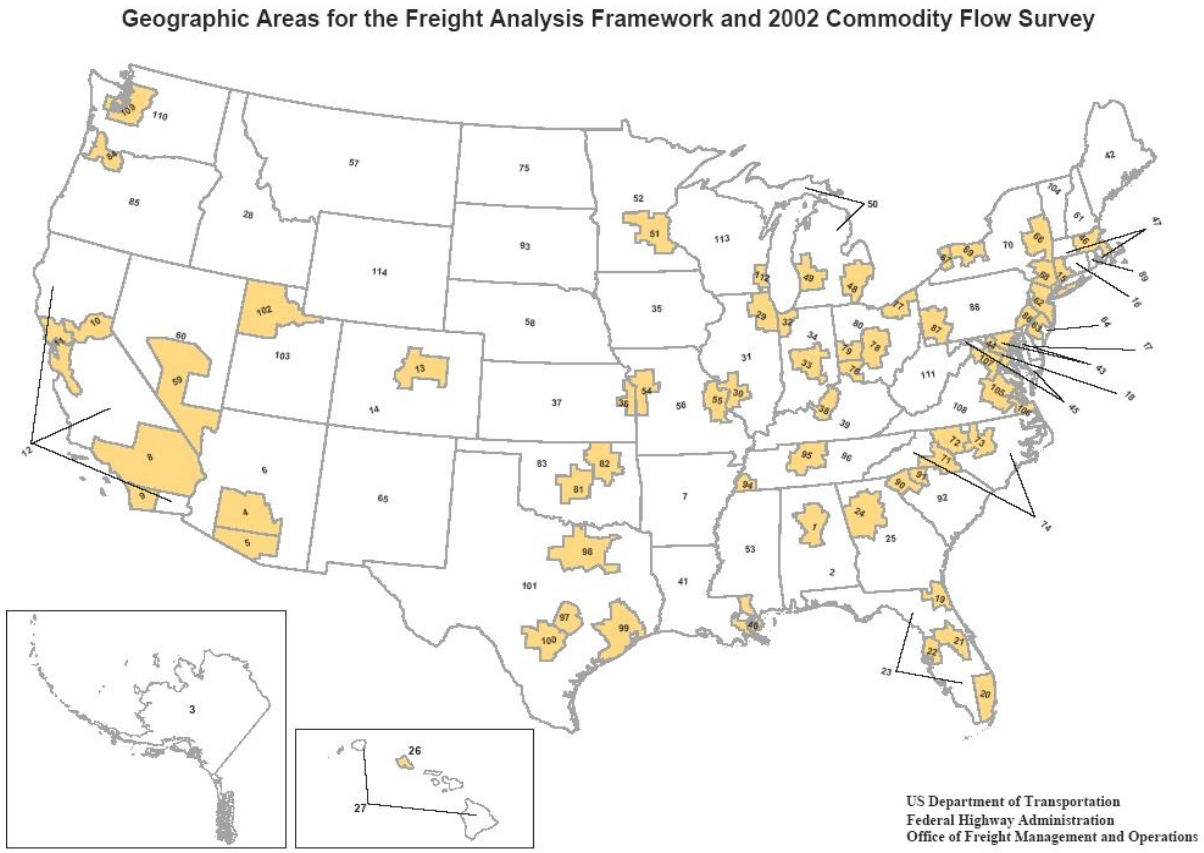
Scatter plot for the 27 FAZ Model



UAHuntsville
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

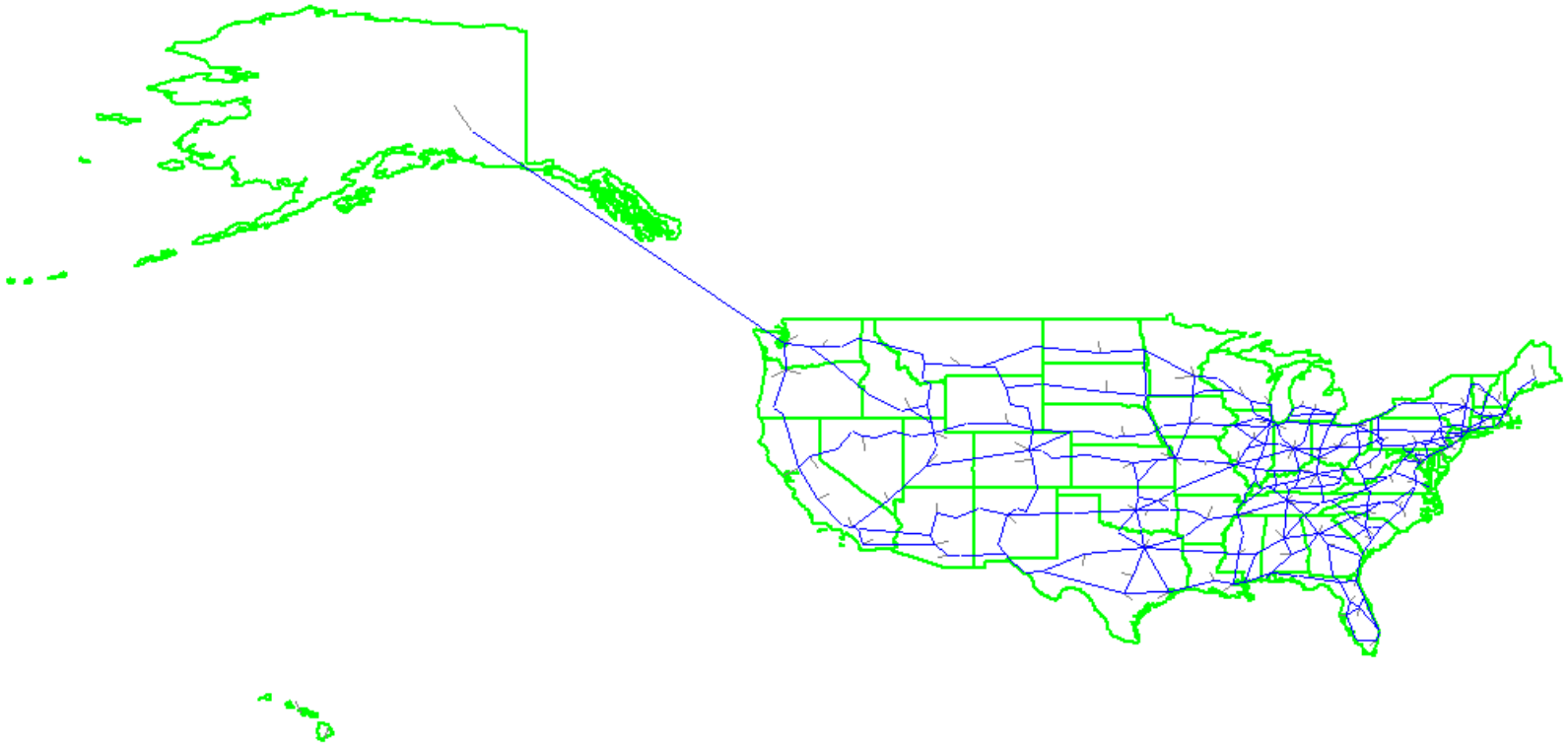
A Methodology to Use FAF2 Data to Forecast Statewide External-External Trips

Freight Analysis Framework v. 2.2

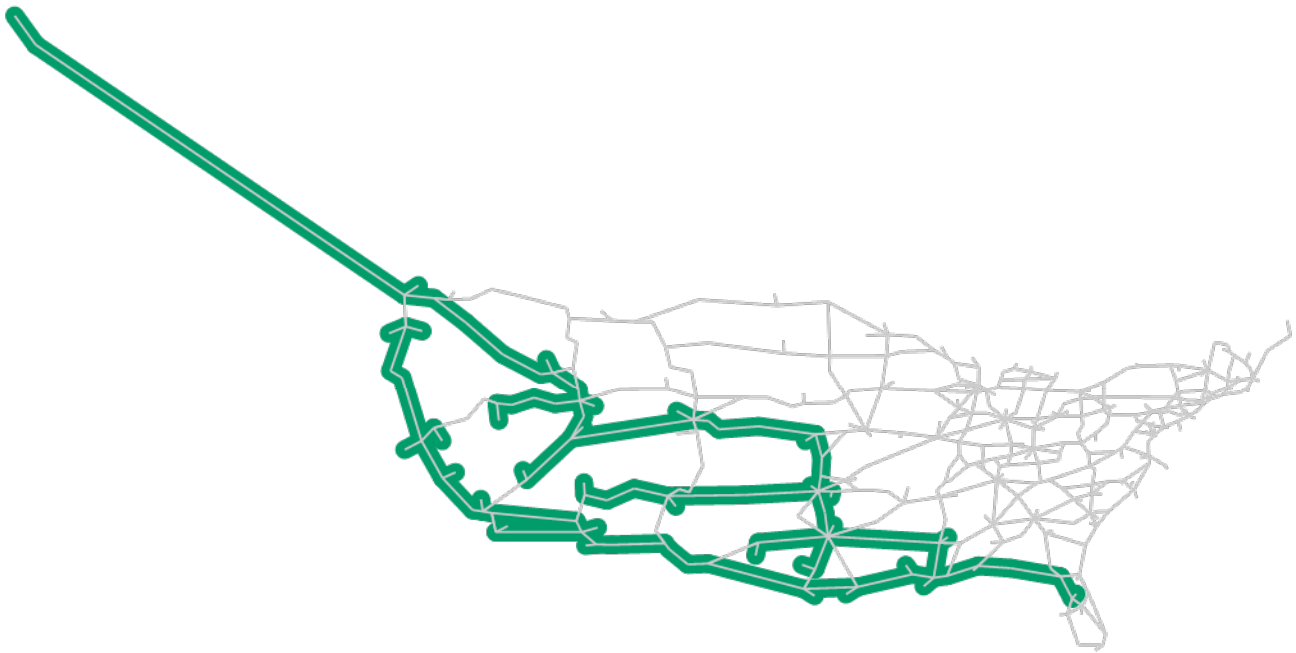


- 114 Zones
- 17 Ports of Entry
- 43 Commodities
- 7 Modes

National Network

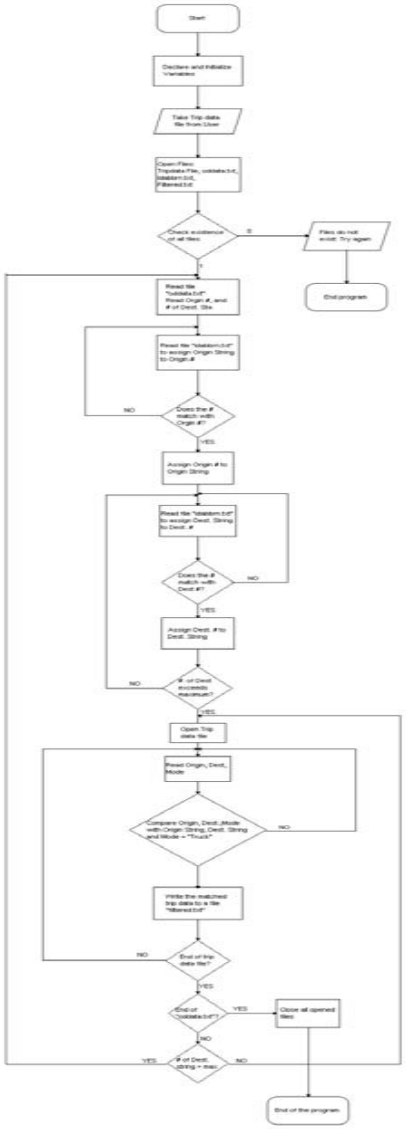


From Orlando Thru Alabama



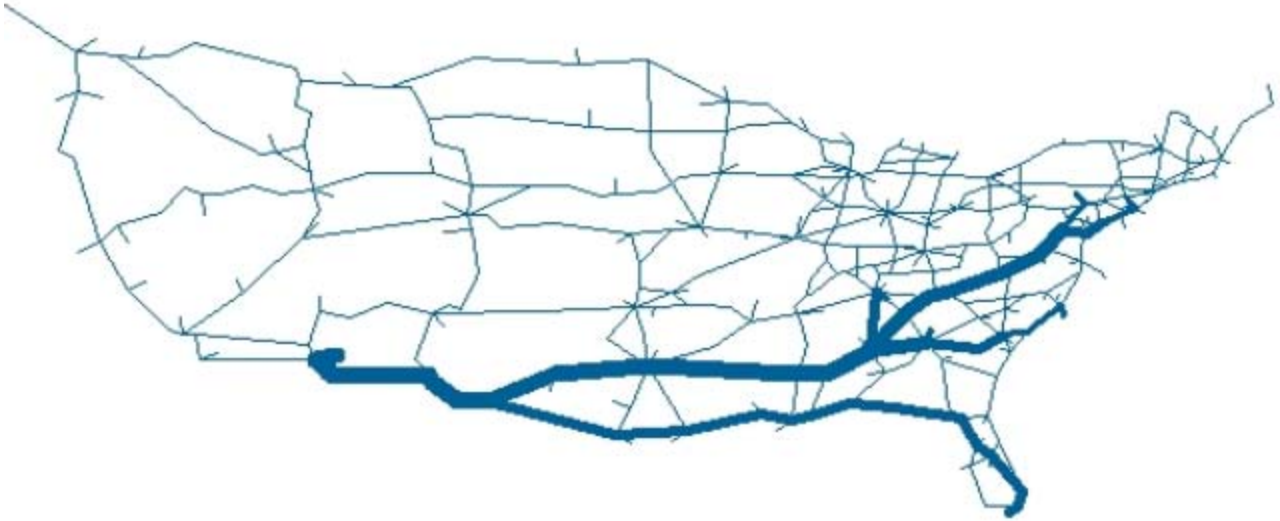
FAF2 Database

- Developed queries in Access to export the IE and EI trips
- Exported the entire database to develop the EE trips – used C++ program flowcharted

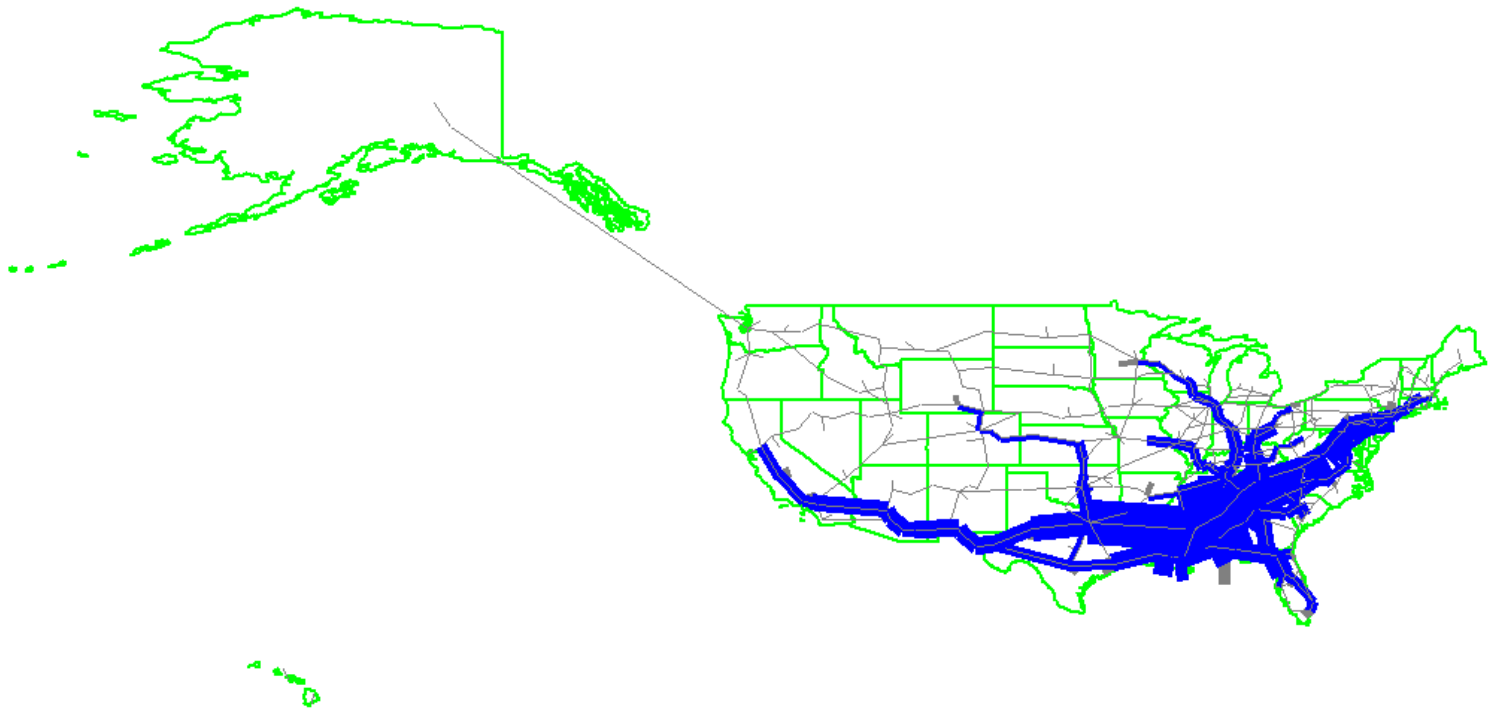


Commodity Specific EE Flows

Base metal flows through Alabama



Alabama IE, EI and EE Flows

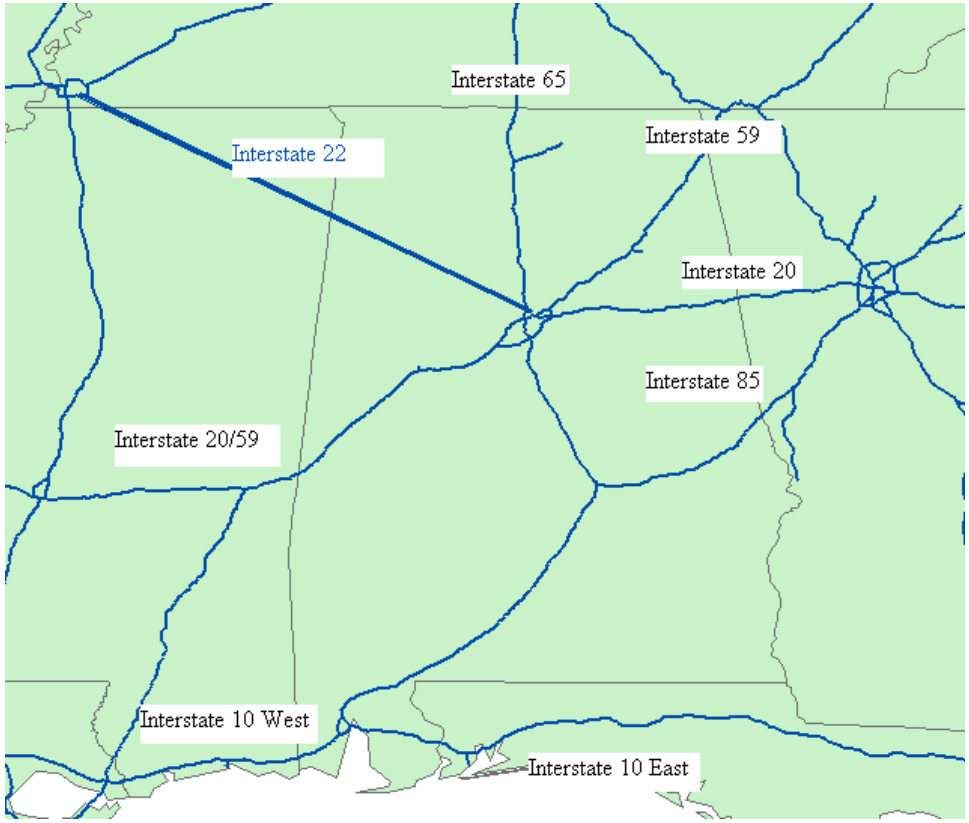


Initial Validation at State Boundary

	Trucks/day ALDOT	Tons/Year Model	Tons/Day	Tons/Truck	Pounds/ Truck
I65	7,768	52,071,250	142,661	18.37	36,730
I59	4,758	47,408,170	129,885	27.30	54,601
I20	14,531	38,163,040	104,556	7.20	14,390
I85	6,070	42,259,400	115,779	19.07	38,149
I10E	6,334	13,234,480	36,259	5.72	11,450
I10W	9,979	22,101,760	60,553	6.07	12,136
I59W	8,875	107,198,800	293,695	33.09	66,188

Weighted average of tons per truck crossing Alabama's borders is 15 tons. Variances in weight results from differences in commodities being shipped different directions.

Application of FAF2 - Statewide

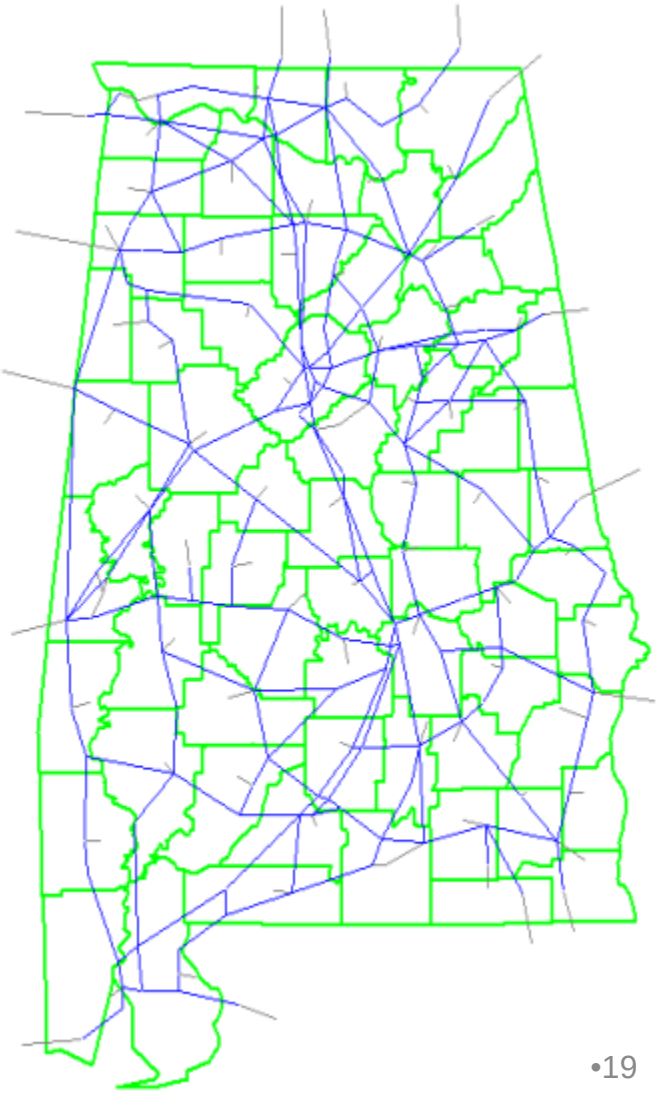


Change in Truck Volumes

Interstate	2015	2035
I-22	4,820	7,230
I-65	-920	-1,400
I-20	3,900	5,830

Application of FAF2 – Statewide/MPO

- Internal to Zone 1
- Internal to Zone 2
- From Zone 1 to Zone 2
- From Zone 2 to Zone 1
- From Zone 1 to locations outside Alabama
- From Zone 2 to locations outside Alabama
- From outside Alabama to Zone 1
- From outside Alabama to Zone 2
- National Pass-Through



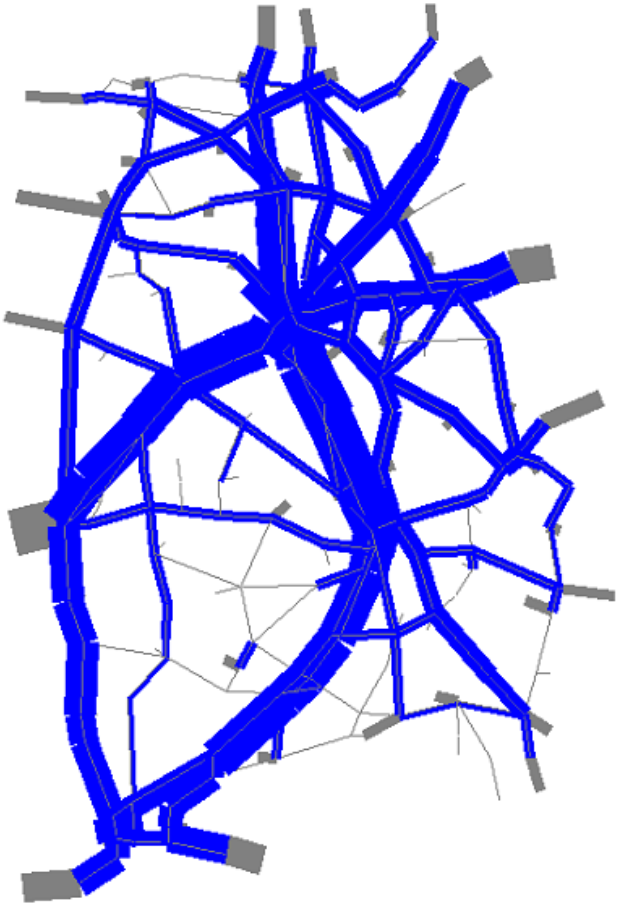
FAF2 - Alabama Statewide Model

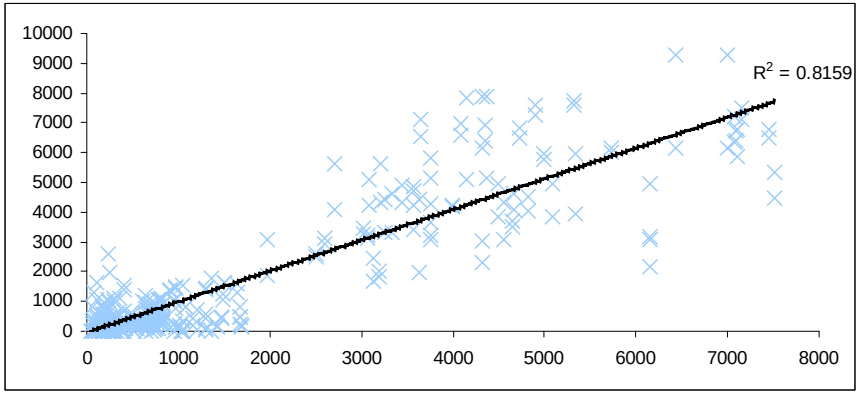
$$PA_i = (NFD) * \left[\frac{W_1 * P_i}{\sum P_j} + \frac{W_2 * PI_i}{\sum I_j} + \frac{W_3 * E_i}{\sum E_j} + \frac{W_4 * VOS_i}{\sum VOS_j} \right]$$

$$\sum PA_i = \sum NFD_{ab}$$

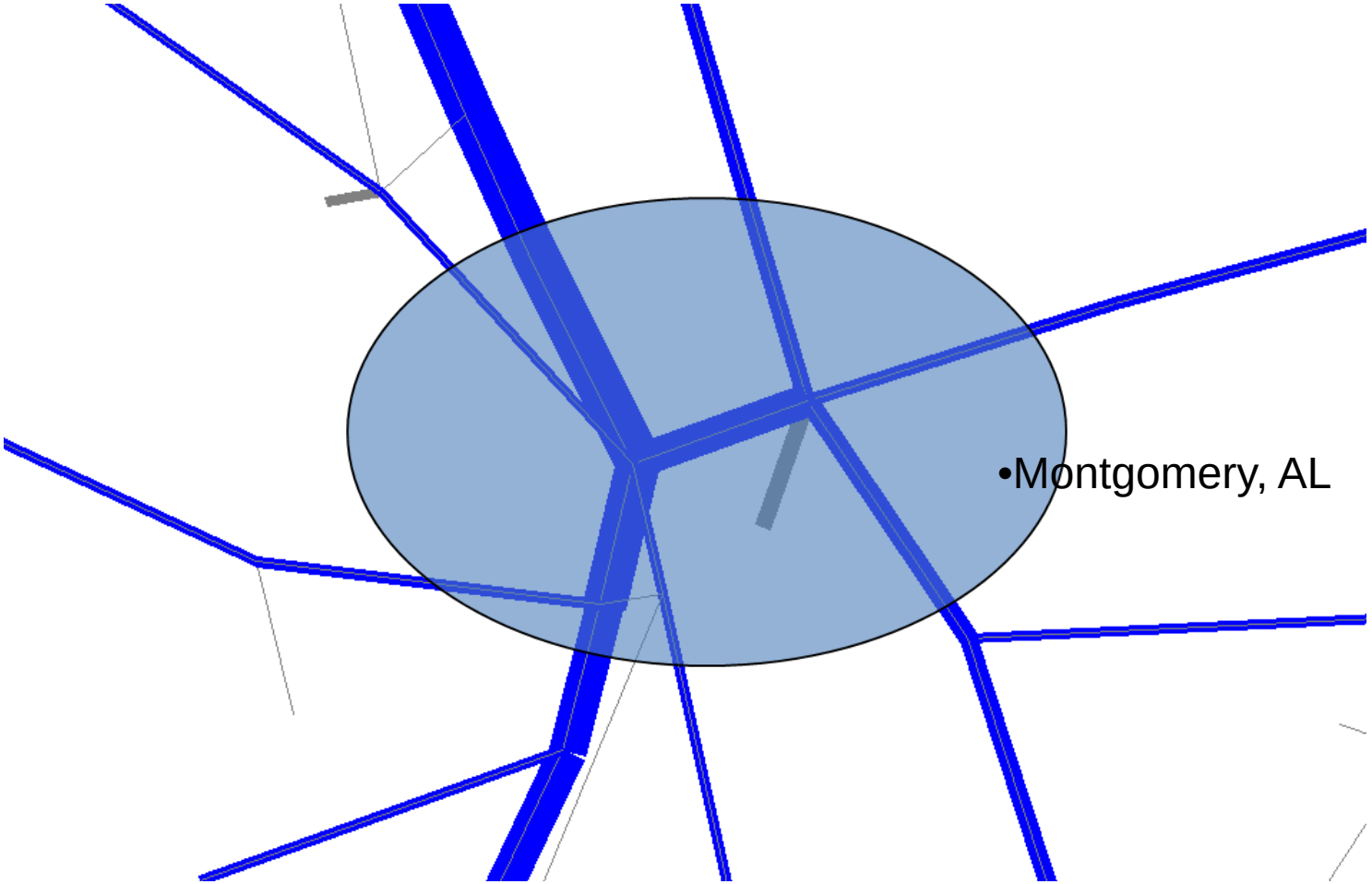
$$\sum_{i=1}^{4} W_i = 1$$

$$W_i = Range(0,1)$$

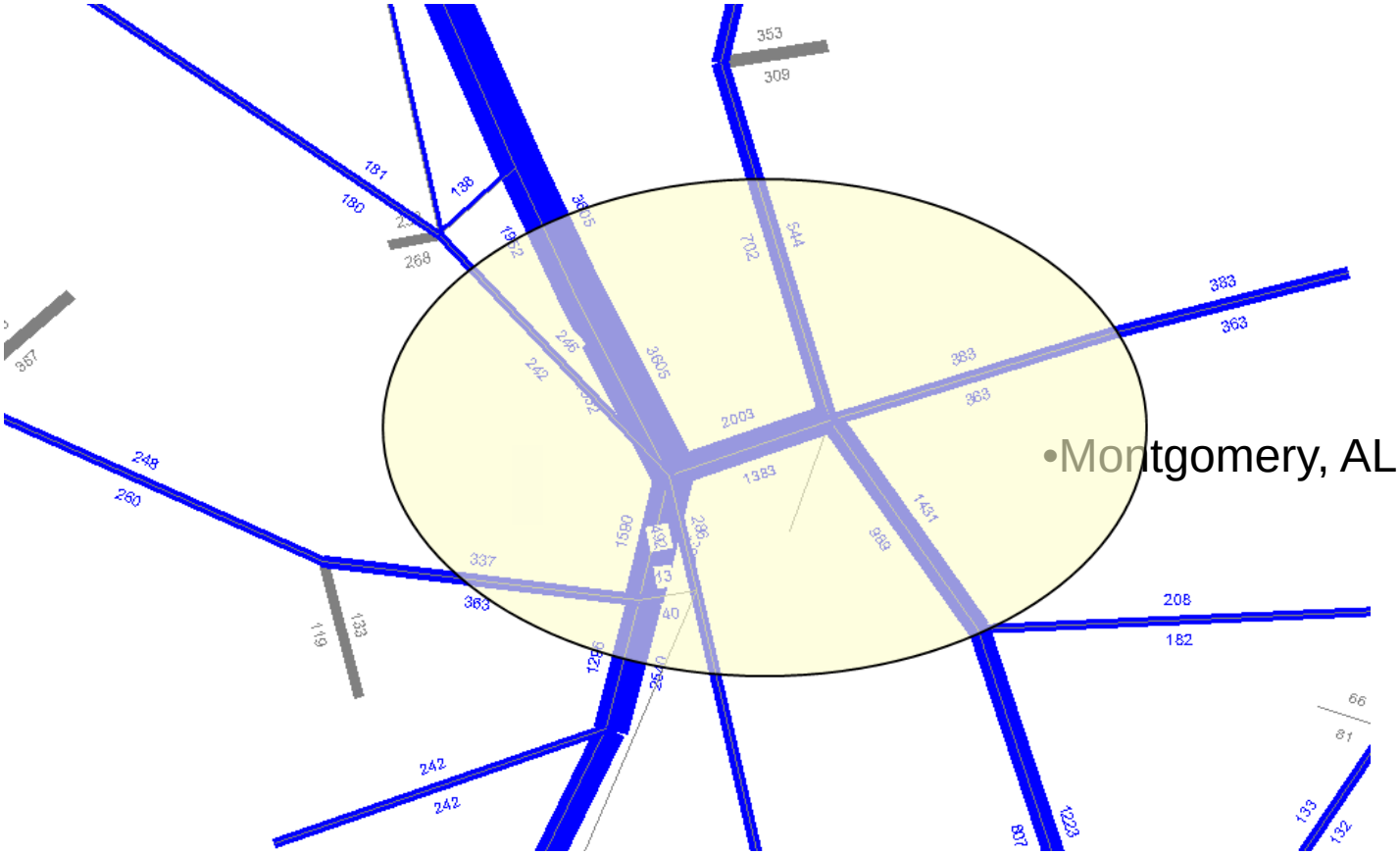




Montgomery Example



Pass Through Montgomery

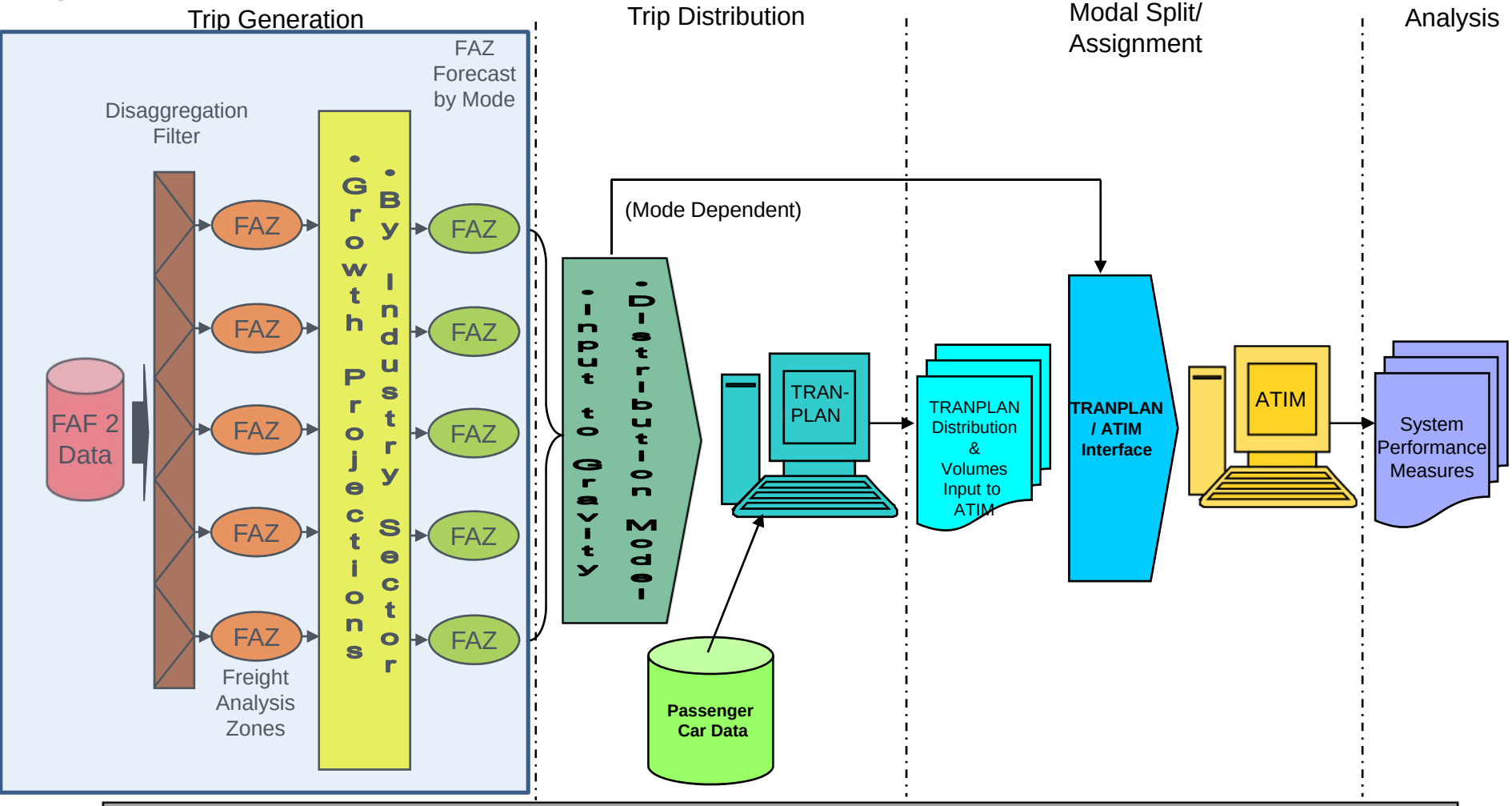


- Montgomery, AL

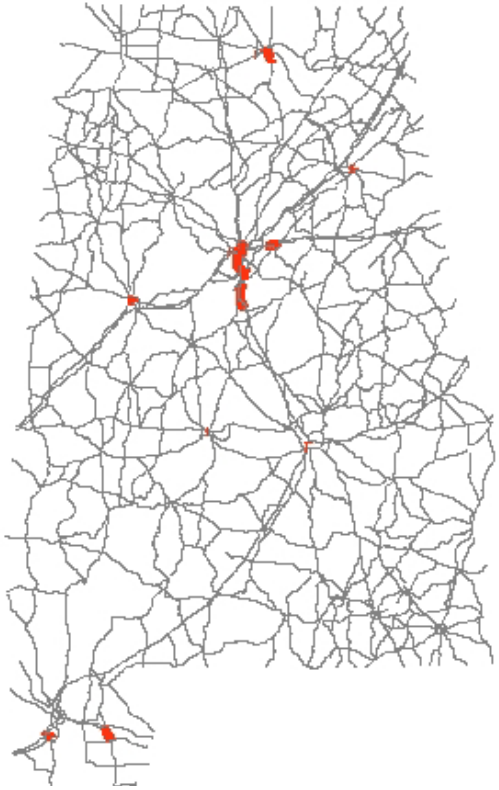
EE Project Conclusions

- Effective use of FAF2
- Enhance statewide models
- Transferable to MPO models

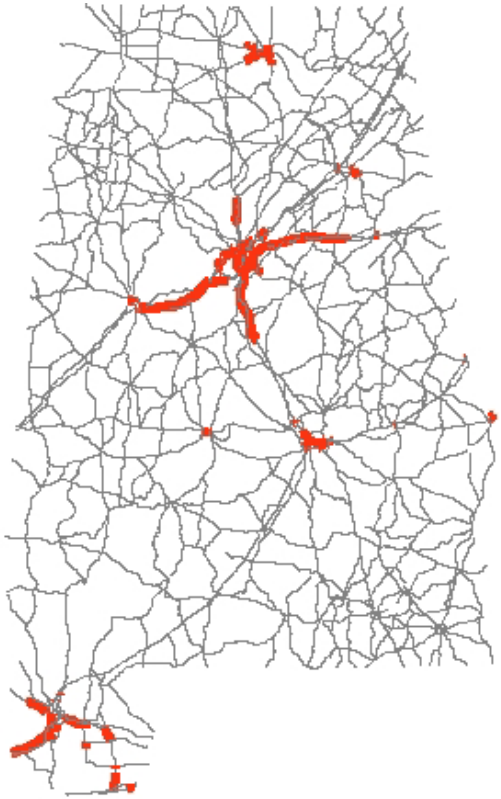
Freight Planning Framework



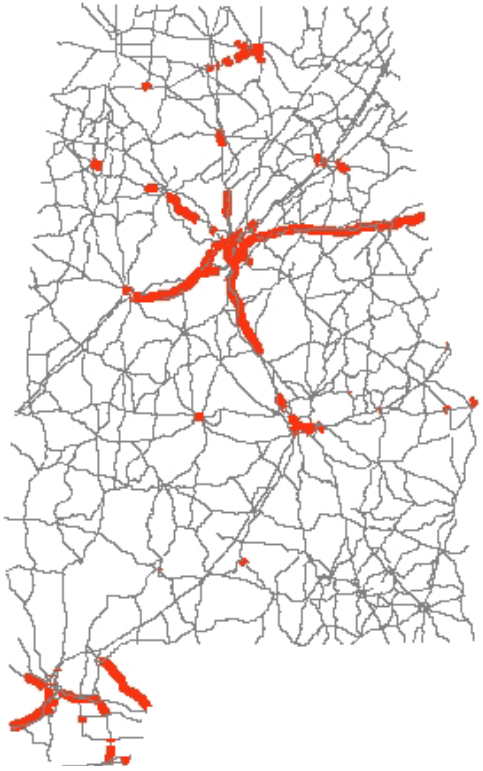
Trend Line vs Industry Sector Projections



Current congestion locations

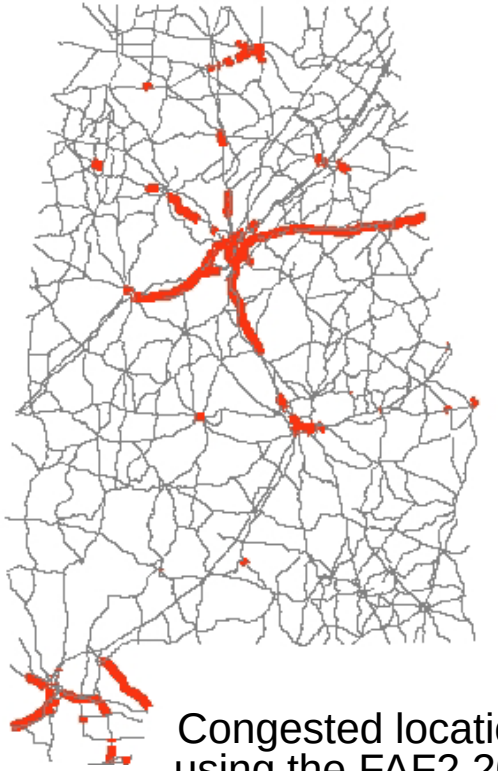


Congested locations using trend line analysis

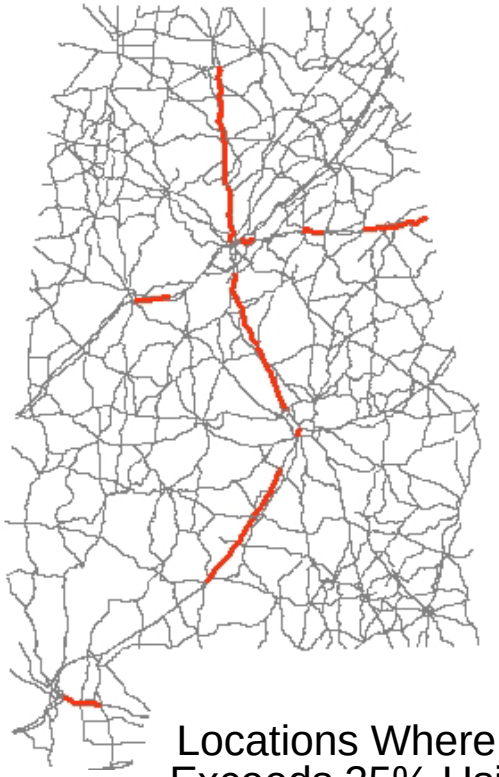


Congested locations using the FAF2 2015 projection

TRANPLAN V/C vs ATIM Time Delay Congestion



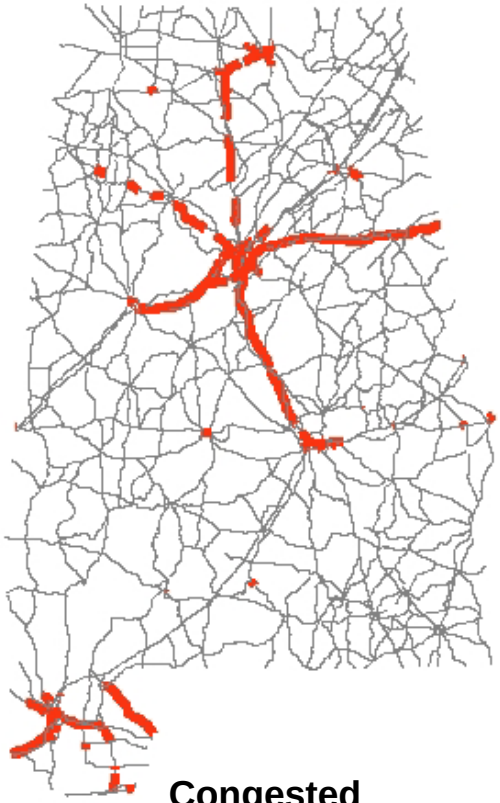
Congested locations using the FAF2 2015 projection



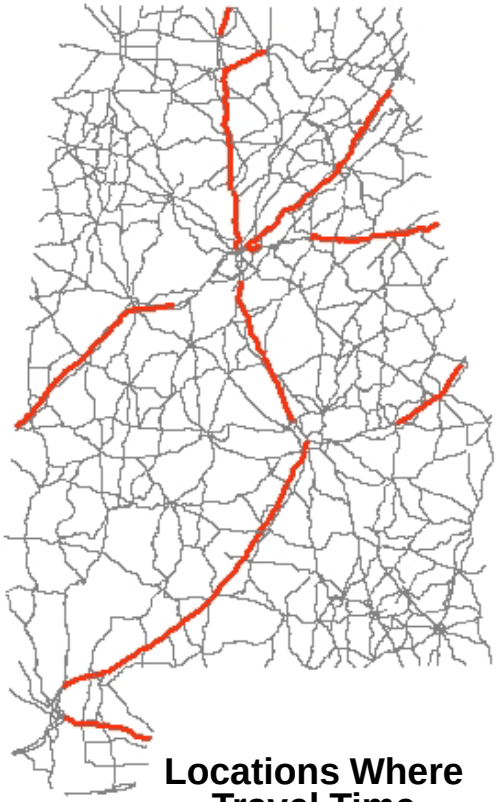
Locations Where Travel Time Exceeds 25% Using the FAF2 2015 Projection

- Apparent discrepancy between the congestion calculations.
- The models are indicating that there are locations of congestion defined by the v/c where vehicle travel times are less than free flow speed but greater than the 25% threshold

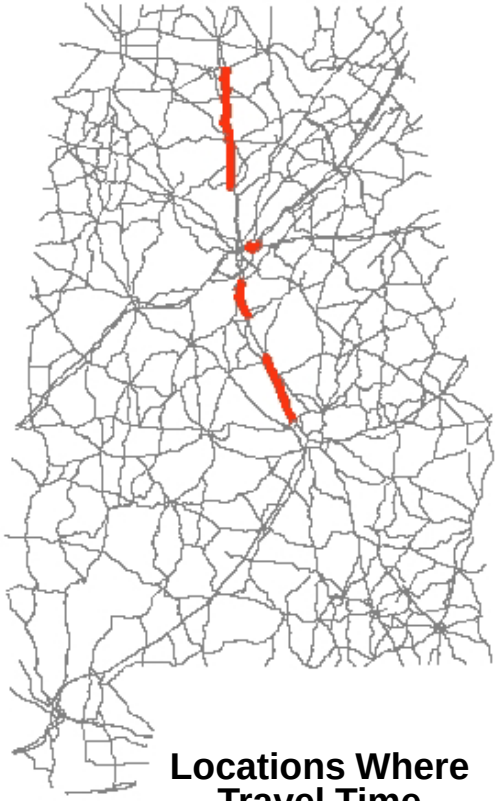
Doubling of Truck Traffic



Congested Locations Doubling the FAF2 2002 Volumes



Locations Where Travel Time Exceeds 25% When Truck Traffic is Doubled From FAF2 2002 Volumes



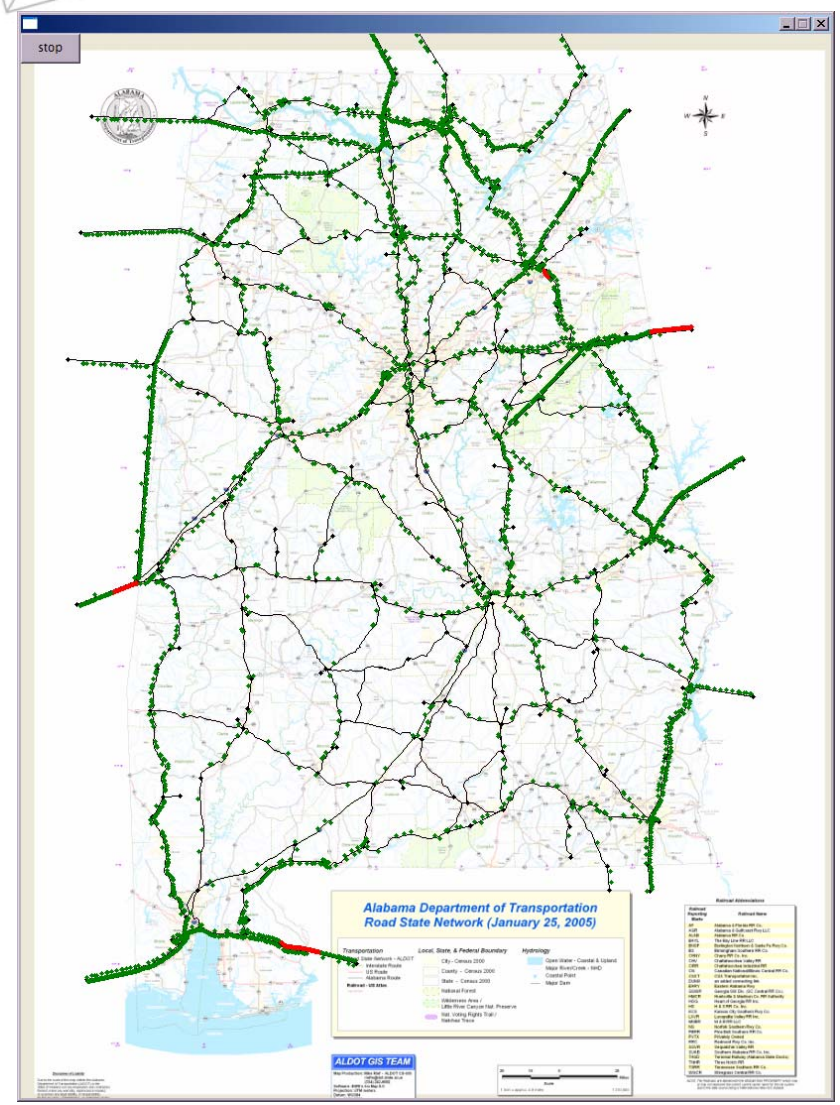
Locations Where Travel Time Exceeds 100% When FAF2 2002 Volumes are Doubled

These scenarios assume static capacity

Model Enhancement

- The Alabama Transportation Infrastructure Model (ATIM) has been very successful as a communication and educational tool
- Unfortunately, after two years of continued development it became obvious that the software used to create and run the discrete event simulation, ProModel, was at the limits of its capabilities.
- The UAH research team was working with the University of Hamburg on a separate project where the Hamburg team was working in the Java-based programming environment for discrete event simulation.
- The capability of Java expands the capabilities of discrete event modeling into “agent-based” simulation where each entity in the model is capable of using a logic framework to maneuver the simulated network.
- This capability overcomes many of the limitations the UAH research team had encountered with ProModel and adds desirable capabilities.

Agent Based JAVA ATIM V2.0



Core functions originally outlined for this initial development phase were:

- Fully dynamic movement of individual vehicles
- Dynamic route-planning
- High flexibility of inputs
- Graphical display of vehicles

ATIM V2.0 Future

- **Multiple lanes**—Virtually any primary or secondary road has multiple lanes of traffic, while virtually any urban surface street likely has multiple lanes and/or turn lanes. Therefore, one of the first future developments will likely be incorporation of multiple lanes in the model and the logic for lane changes.

- **Local traffic**—Interest has already developed in modeling local urban traffic, such as that of Birmingham or Mobile. Because of the flexibility of our model, the only real changes is the input files; however, pre-run data conditioning, we have found, is an important step to realistic modeling.

- **Multi-modal traffic**—Inclusion of rail and ship traffic is a logical next step for our model development. Model flexibility allows these networks and "vehicles" to be included easily.

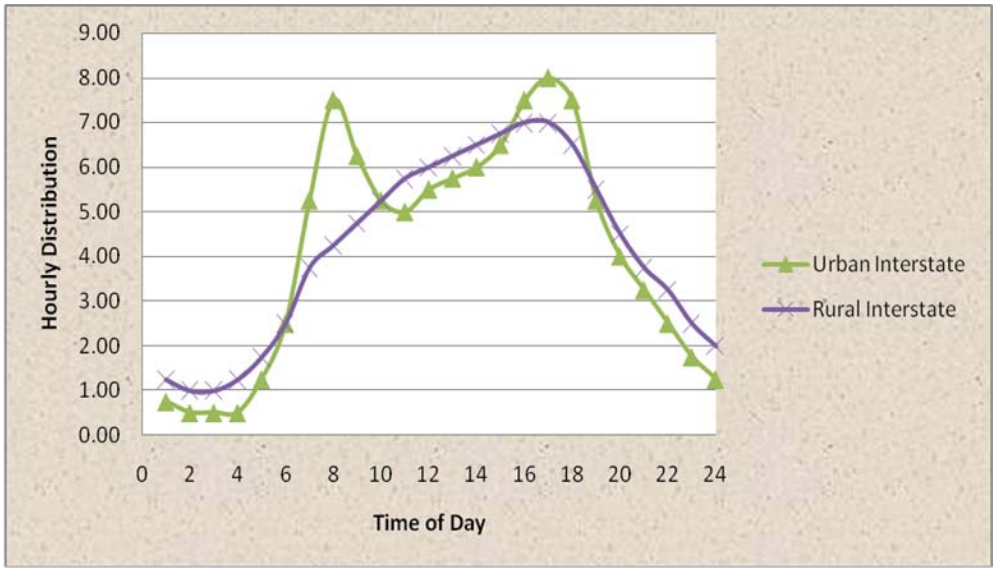
ATIM V2.0 Future (2)

- **Additional routes**—ATIM V2.0 provides for rapid inclusion of new roadways. One simply needs to add the appropriate nodes and links to the input files, and the model takes care of the rest.

- **Incident Simulation** - The agent-based capability allows each driver to make route decisions based upon the incident and their knowledge of the transportation network.

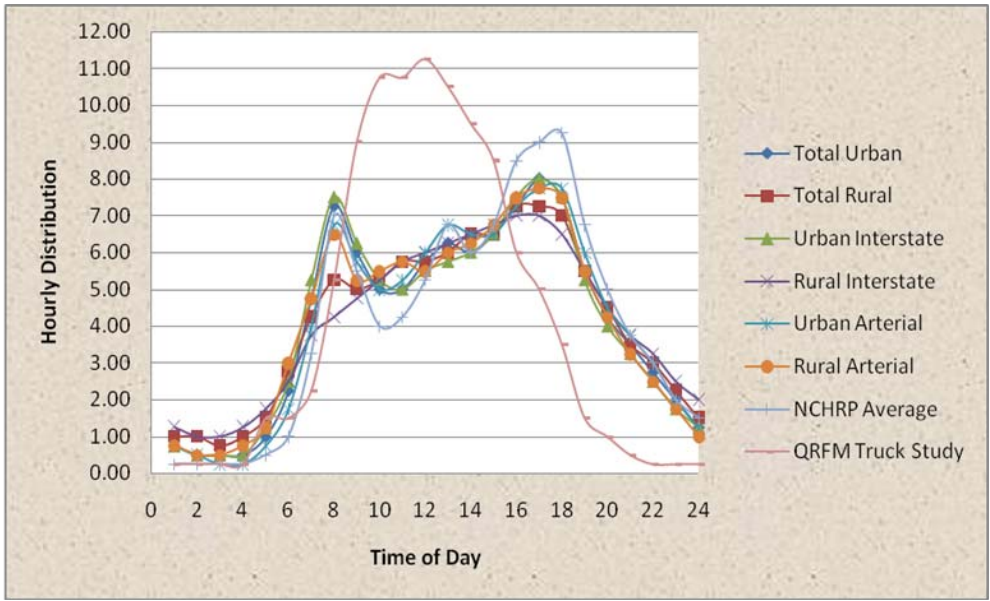
- **Conclusion -** ATIM V2.0 is a powerful, flexible and extensible agent-based model of freight traffic on Alabama roadways.
  - In a few short months, the research team has incorporated a large number of core functionalities ready for verification and validation study.
  - The validated model will allow further development in exciting new areas and expand the capacity to communicate transportation systems and issues, and potential solutions, to decision makers.

Rural Time of Day



Urban vs. Rural Interstate - Hourly Distribution from ALDOT Count Stations

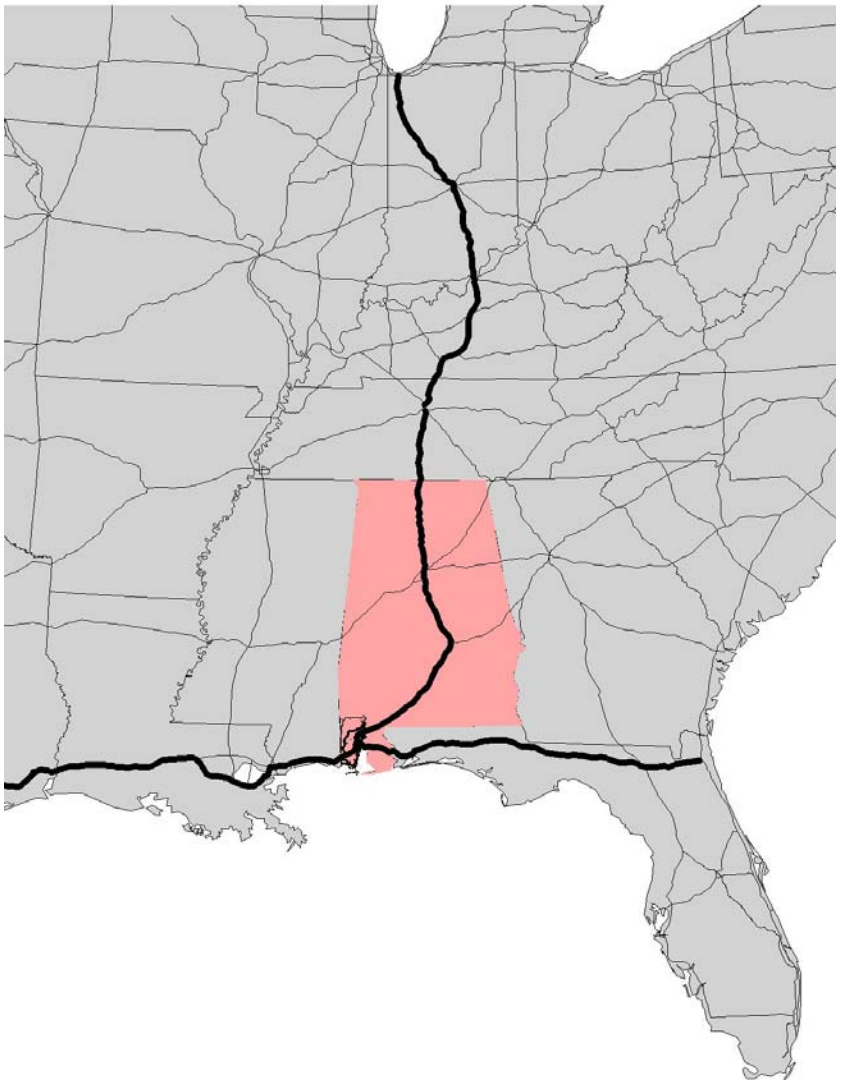
Hourly Profile Comparisons – ALDOT, NCHRP, QRFM



Mobile MPO Freight Planning

Mobile, AL

Convergence of Two Interstates:
I-10 running EW
I-65 running NS



Mobile's Freight Reality

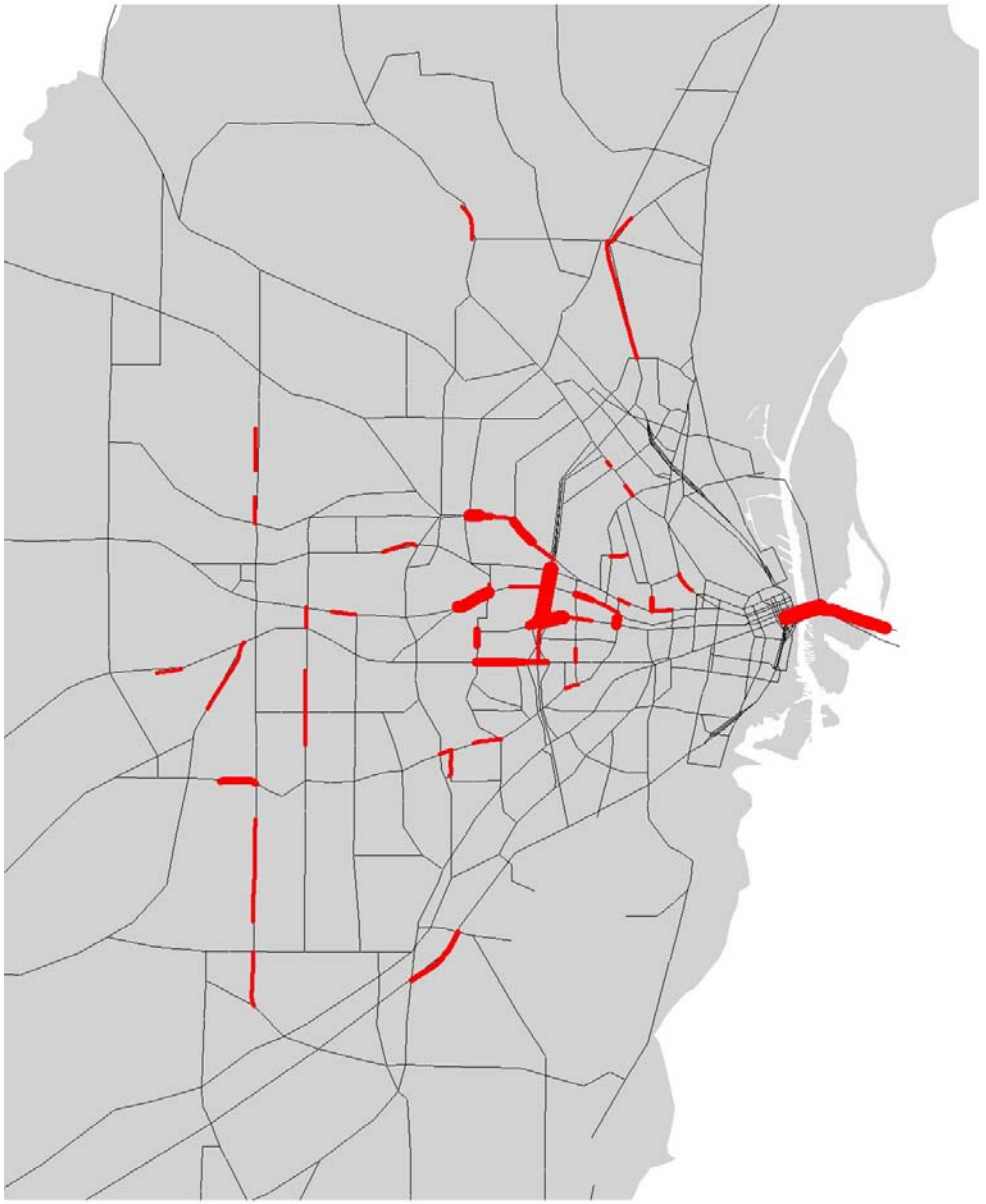
- 5 class A Railroads in Mobile
- Mouth of Alabama's inland Waterways; 4500 miles of system via Tenn-Tom
- 25 steam ship agencies
- 4 foreign trade zones
- 60 trucking companies
- 4 bulk liquid terminals
- 13 warehouses, 9 of which are US Customs bonded
- 16 shipbuilding or ship repair companies

Mobile's 2007 Network

Red=Capacity Deficiency

Interstate 65
Traffic Count = 98,500
Capacity = 88,800

Wallace Tunnels
Traffic Count = 67,000
Capacity = 56,000



Activity in Mobile

- Thyssen Krupp
- Choctaw Point
- Northrup Grummond / EADS
- Expansion of Austal Ship Building
- Berg Steel

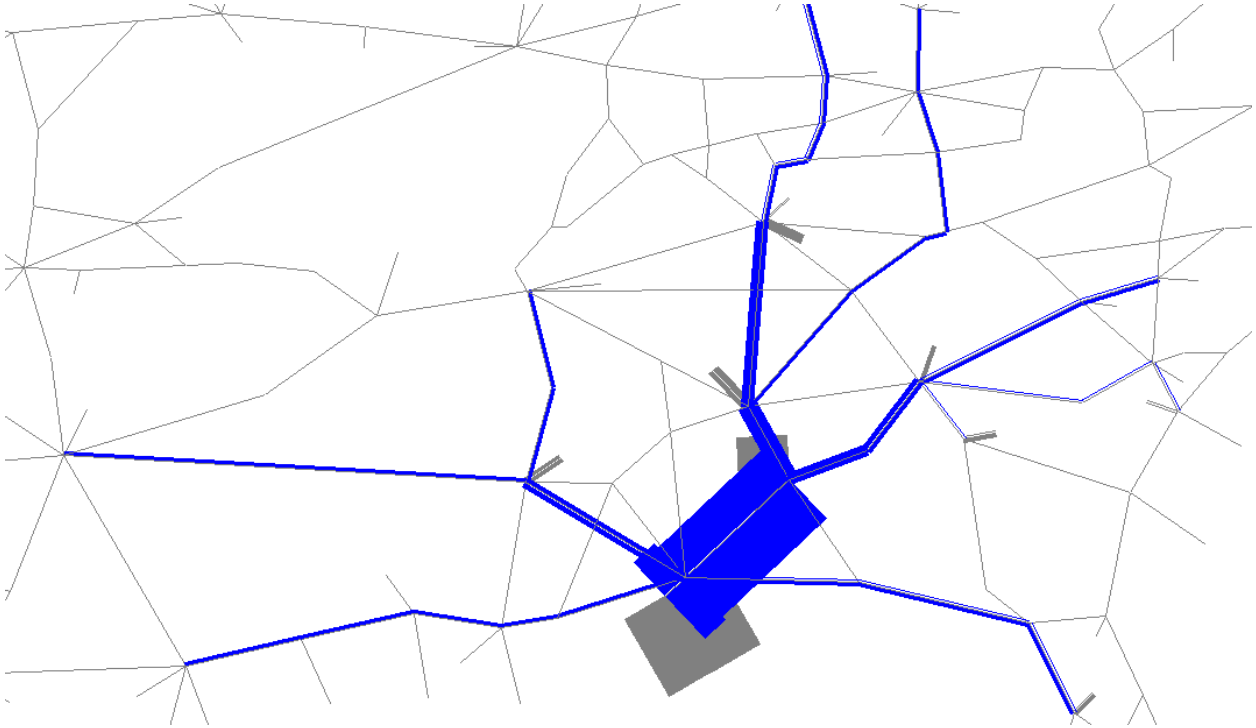
Why Should We Start Planning for Freight at the MPO level?

- It is pretty obvious
- Plan will include a truck matrix to preload prior to equilibrium assignment
  - Ability to validate freight movements
  - Ability to forecast freight movements and potential conflicts; identify projects
- Regional freight profile, with potential freight projects identified as an element to TLRP
- We don’t want infrastructure to be an impediment to our growth

External-External

- Compared Ktons crossing AL to ALDOT
- 28,800 lbs / truck
- Factor 20% empty
- 35,500 lbs / truck
- Use FAF2 2035 Forecast to determine E-E flow on I-10 and I-65

Port Analysis



- 2002 and 2035
- Being verified to actual Port Data

Freight Trips Generated

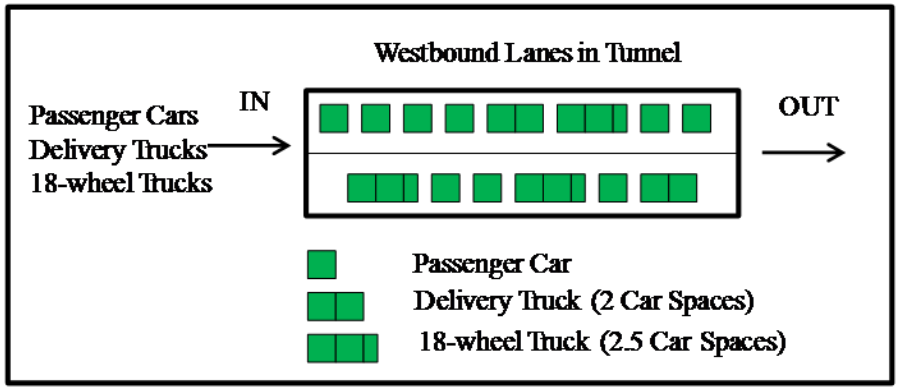
Shipments Per Employee		Inbound	Outbound
	7 - Food	16.0	26.3
	10-12 -Construction Mat'ls	161.4	166.9
	17 - Petroleum	100.9	257.1
	20 - Chemicals	12.0	26.6
	24 - Plastics	68.8	193.8
	26 - Wood Products	406.9	-
	28 - Paper	51.0	63.0
	30 - Textiles	28.2	11.4
	32 - Primary Metals	50.1	60.1
	33 - Fabricated Metals	19.1	23.6
	34 - Machinery	32.7	21.2
	37 - Transportation	3.9	17.8
	40 - Misc. Manufacturing	0.4	1.7
	41 - Waste/Scrap	13.9	7.9
	42 - Mixed Freight	17.5	57.3
	Overall	23.1	36.9

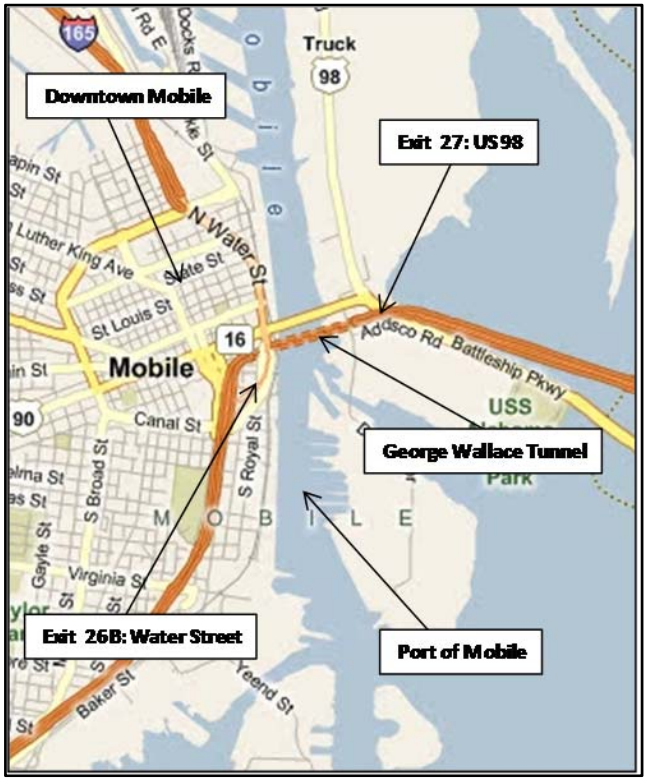
Mode Choice & Freight Distribution

Type of Vehicles Used		Inbound	Outbound	Combined
	Truck	64.0%	77.5%	70.0%
	Rail	22.0%	10.0%	16.7%
	Water	12.0%	12.5%	12.2%
	Air	20.0%	0.0%	1.1%

Freight O/D In/Outside		Origins	Destinations
	w/in Mobile County	14.5%	16.4%
	Outside Mobile County	84.5%	80.7%
	Local Port	1.0%	2.8%
Freight O/D Compass Direction			
	North	25.5%	30.2%
	East	59.4%	12.3%
	West	14.5%	57.5%
	South	0.6%	0.0%

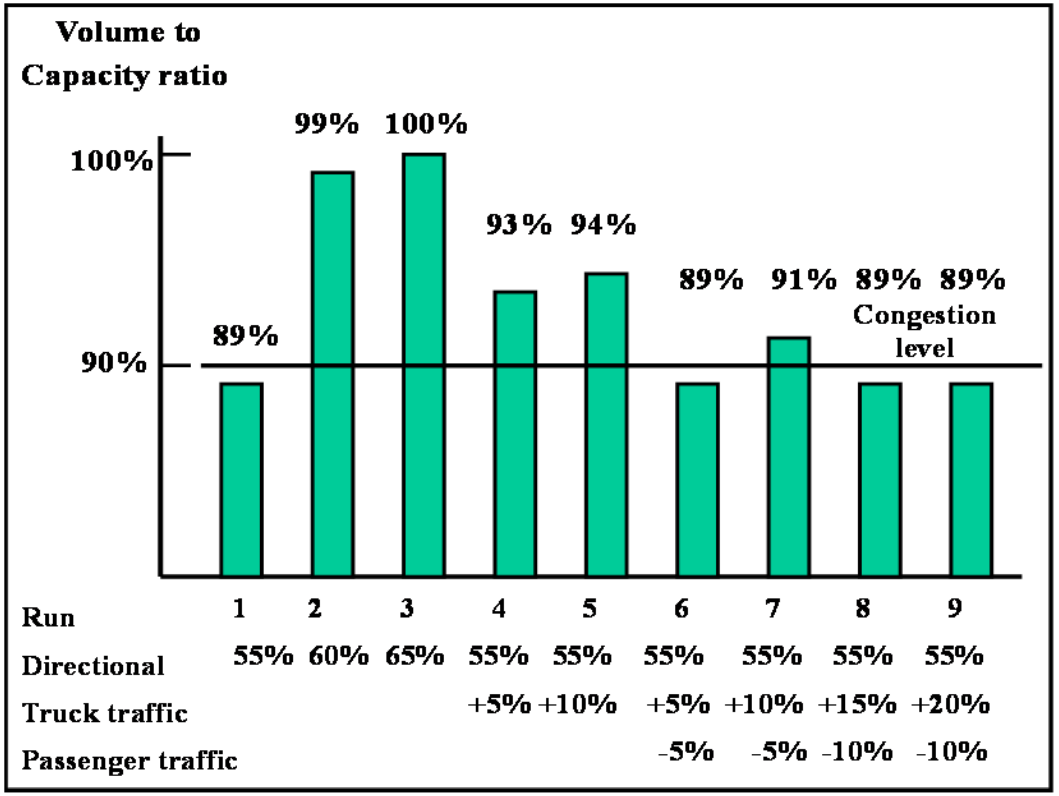
Tunnel – Commuter Rail





Run	Description
Run1 (Baseline)	Existing traffic volumes
Run2	Increase traffic volume to 60%
Run3	Increase traffic volume to 65%
Run4	Increase truck traffic 5%
Run5	Increase truck traffic 10%
Run6	Decrease car traffic 5% and increase truck traffic 5%
Run7	Decrease car traffic 5% and increase truck traffic 10%
Run8	Decrease car traffic 10% and increase truck traffic 15%
Run9	Decrease car traffic 10% and increase truck traffic 20%

Tunnel Simulation Results



- A 15% increase in truck traffic with a 10% decrease in passenger car traffic (Run8) resulted in a volume to capacity ratio of 89%.
- A further increase in truck traffic to 20% with a 10% decrease in passenger car traffic (Run9) also resulted in a volume to capacity ratio of 89%.
- The ability to move passenger vehicles off of the road by implementing a commuter rail system will provide time for capacity solutions to be implemented

Conceptual Framework for Simulation

- The focus of this research is on developing a conceptual framework that reduces the impact of many difficulties.

- When effectively done, simulations can be inexpensive insurance against costly mistakes, especially when significant capital expansions are being considered, as is the case with the large capital investments at seaports.

- This framework greatly reduced the time for development, model debugging, and verification and validation.

- Simulations using the conceptual framework
  - Coal Terminal Model
  - Intermodal Center Model
  - Container Terminal Model
  - Minimizing Disruption caused by Container Inspection at an Intermodal Terminal

Student Research Initiatives

- A Methodology to Use FAF2 Data to Forecast Statewide External-External Trips
- Final Report: The Impact of BRAC on Freight Movement Within North Alabama
- Effectively Using the QRFM to Model Truck Trips in Medium-sized Urban Communities

Published and Accepted Peer Review Papers

Published Papers

Published Journal Articles

"A Simulation Approach to Evaluating Productivity Improvement at a Seaport Coal Terminal," Harris, G. A, A. Holden, B. Schroer, and D.P.F. Moeller; *Transportation Research Record: Journal of the Transportation Research Board,* Vol. 2062/2008, pp. 19-24.

Published Conference Proceedings

- *2nd Annual National Urban Freight Conference*

"Using Simulation to Evaluate and Improve the Operations of a Seaport Container Terminal," Gregory A. Harris, Lauren Jennings and Bernard J. Schroer, University of Alabama in Huntsville; Huntsville, AL, and Dietmar P.F. Moeller, University of Hamburg; Hamburg, Germany

- *10th International Conference on Application of Advanced Technologies in Transportation*

"Application of Simulation to Improve Volume through a Seaport Coal Terminal," Harris, Gregory A., Anthony Holden, Bernard Schroer and Dietmar P.F. Möeller. *Proceedings of the 10th International Conference on Application of Advanced Technologies in Transportation,* Athens, Greece, May 2008.

"Using a Gravity Distribution Model and Discrete Event Simulation to Enhance Freight Planning," Harris, Gregory A., Michael D. Anderson and Heather R. Shar. *Proceedings of the 10th International Conference on Application of Advanced Technologies in Transportation,* Athens, Greece, May 2008.

"Using a Federal Database and New Factors for Disaggregation of Freight to a Local Level," Anderson, Michael D., Gregory A. Harris and Niles Schoening. *Proceedings of the 10th International Conference on Application of Advanced Technologies in Transportation,* Athens, Greece, May 2008.

Published Papers (2)

Published Conference Proceedings

- *Transportation Research Forum Annual Conference*

"Developing Freight Analysis Zones at a State Level: A Cluster Analysis Approach." Harris, G.A., Farrington, P.A., Anderson, M.D., Schoening, N., Swain, J., *Proceedings of the Transportation Research Forum Annual Conference*, Fort Worth, TX., March 17-19, 2008.

"Cost Analysis of Proposed Truck-Only Highway Segments in Alabama." Anderson, M.D., Youngblood, A.D., Harris, G.A., *Proceedings of the Transportation Research Forum Annual Conference*, Fort Worth, TX., March 17-19, 2008.

- *Huntsville Simulation Conference*

"Simulating the Impact of Increased Truck Traffic through Tunnel Crossing Mobile River," Gregory Harris, Mike Spayd, Michael Anderson and Bernard Schroer, University of Alabama in Huntsville, Huntsville, AL USA, and Dietmar P.F. Moeller University of Hamburg, Hamburg, Germany

"Container Security Inspection: Simulation to Evaluate Various Container Sampling Plans on Port Operations," Gregory Harris, Maruf Rahman and Bernard Schroer, University of Alabama in Huntsville, Huntsville, AL USA, and Dietmar P.F. Moeller University of Hamburg, Hamburg, Germany

"Conceptual Framework for Simulating Seaport Terminals," Bernard Schroer, Maruf Rahman, and Gregory Harris, University of Alabama in Huntsville, Huntsville, AL USA, and Dietmar P.F. Moeller University of Hamburg, Hamburg, Germany

"Container Terminal Simulation," Gregory A. Harris, Lauren Jennings and Bernard J. Schroer, University of Alabama in Huntsville; Huntsville, AL, and Dietmar P.F. Moeller, University of Hamburg; Hamburg, Germany

Pending Papers

Submitted Journal Papers

"Simulation of an Intermodal Container Center Served by Air, Rail and Truck," Bernard J. Schroer, Gregory A. Harris and William Killingsworth, University of Alabama in Huntsville, Huntsville, AL USA, and Dietmar P.F. Moeller, University of Hamburg, Hamburg, Germany

SUBMITTED to the JOURNAL of ADVANCED TRANSPORTATION

"Using FAF2 Data to Analyze Freight Impact of Interstate 22," Michael D. Anderson, Mary Catherine Dondapati, and Gregory A. Harris, The University of Alabama in Huntsville, Huntsville, AL, USA

SUBMITTED to the JOURNAL of TRANSPORTATION RESEARCH FORUM

"A Freight Planning Framework," Gregory A. Harris and Michael D. Anderson, University of Alabama in Huntsville, Huntsville, AL, USA

SUBMITTED to TRANSPORT POLICY

Accepted Conference Papers

"Developing Freight Analysis Zones at a State Level: A Cluster Analysis Approach," Gregory A. Harris, Phillip A. Farrington, Michael D. Anderson, Niles Schoening, James Swain, and Nitin Sharma, University of Alabama in Huntsville, Huntsville, Alabama

Transportation Research Board Annual Meeting, January 2009

"Resources to Minimize Disruption Caused by Increased Security Inspection of Containers at an Intermodal Terminal: Application of Simulation," Gregory A. Harris, Bernard J. Schroer, Michael D. Anderson, University of Alabama in Huntsville, Huntsville, AL, USA, and D.P.F. Moëller, University of Hamburg, Hamburg, Germany

Transportation Research Board Annual Meeting, January 2009

"The Application of Lean Enterprise to Improve Seaport Operations," Nicholas Loyd, Lauren C. Jennings, Jeff Siniard, Michael L. Spayd, Anthony Holden, and George Rittenhouse, University of Alabama in Huntsville, Huntsville, AL

Transportation Research Board Annual Meeting, January 2009

Conclusions

- The Freight Analysis Zone research led to the development of a methodology for integrating freight into the transportation models and plans at the state level and at the Metropolitan Planning Organization (MPO) level.
- The Freight Planning Framework (FPF) is a significant step forward in freight planning and modeling.
- There is also a significant amount of research to do to refine each individual part of the FPF process.
- This will be a main focus as the UAH research team continues on the path to improve the ability of states, regional planning offices (RPOs) and MPOs to integrate freight considerations into plans and activities.

Next Steps

1. Research & Development of the Freight Planning Framework (FPF)
   a. Trip Generation - Development of Freight Data and Analysis Methodologies and Tools
      i. New freight planning factors will be developed and utilized to provide more accurate input to the state and MPO Transportation Planner

   b. Trip Distribution – Integration of Freight and Transit System Loads
      i. Develop appropriate planning levels for freight and how they relate to traditional TAZs.
      ii. Once the planning level is determined, integrate and distribute the load on the transportation network.
      iii. Develop integration methods and techniques of freight, transit and passenger travel loads.

   c. Modal Split and Assignment – State and Local Simulations
      i. Continue development of Version 2.0 of the ATIM model in JAVA including the incorporation of infrastructure alternatives, improved graphics capabilities, the ability to model incidents, queues and recovery time to fully understand the traffic flow.

   d. Analysis – System Performance Measures
      i. Develop and evaluate transportation system performance measures at the state and MPO level.

Next Steps (2)

2. Evaluation of Alternative Transportation Modes for Improving Transportation and Freight Flow
   a. Evaluation of Commuter Rail Service Application Between Birmingham, AL and Montgomery, AL.
   b. Evaluation of the Utilization of the International Intermodal Center in Huntsville, AL as an Inland Container Facility for the Port of Mobile.
3. Enhancement and expansion of the application of continuous improvement principles for port operations
   a. Enhancement of Lean Principles in Port Operations Training Class to Include Container Terminal Operations
   b. Expand Lean Training Offerings Customized for Port Operations
4. Student Research Initiatives

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The Final Draft research report has been uploaded to the Freight Data Repository and can be found at:

http://www.uahcmer.com/cmer/data/transporation-infrastructure-alabama

Thank You

Questions?

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