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Tennessee Statewide Travel Forecasting Model Update

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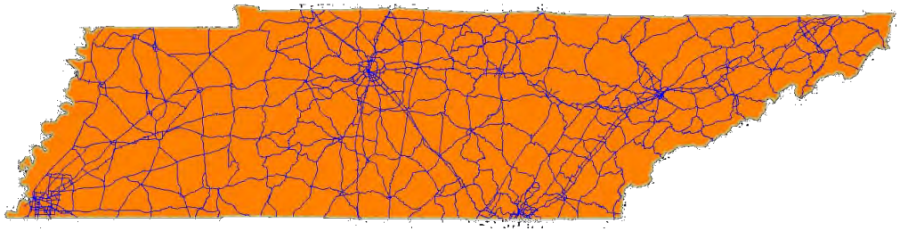
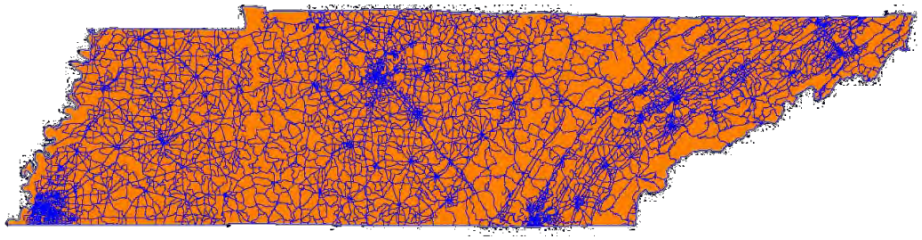
October 9, 2014

Statewide Model Update





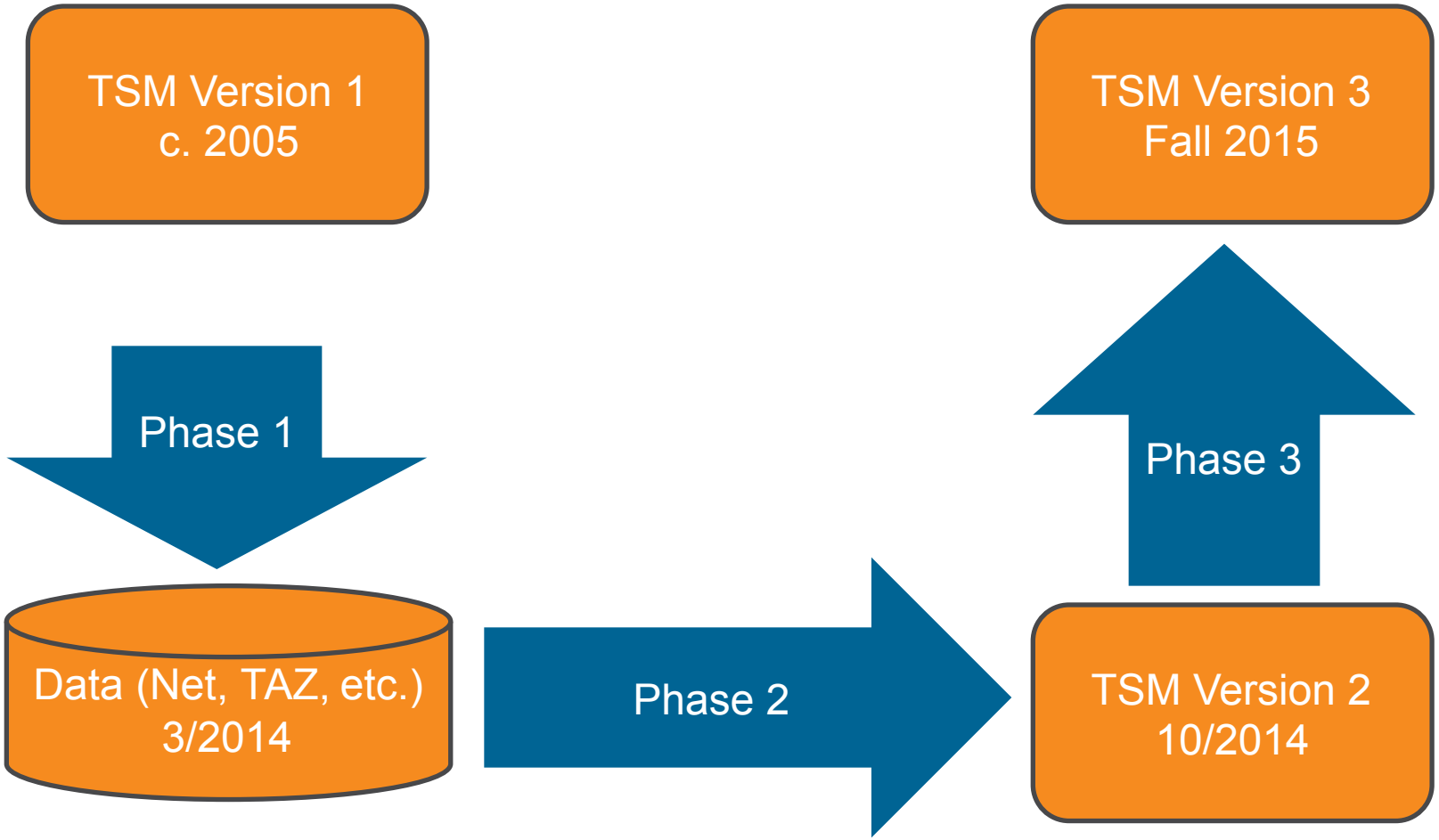
Existing Statewide Model

- 2003 Base – 2030 Horizon
- Only Total Daily Traffic
- Limited Network Coverage
- Limited Sensitivity
  - Re-routing Only

New Statewide Model

- 2010 Base Year – 2040 Horizon Year
- Peak Hour and Daily Traffic
- Expanded Network Coverage
- New Sensitivity to:
  - Network changes
  - Induced demand
  - Alternative future land use scenarios
  - Population changes (aging, etc.)
- Commodity Flow Modeling

Phases and Versions



Phase 1 of the Statewide Model Update: Data Development

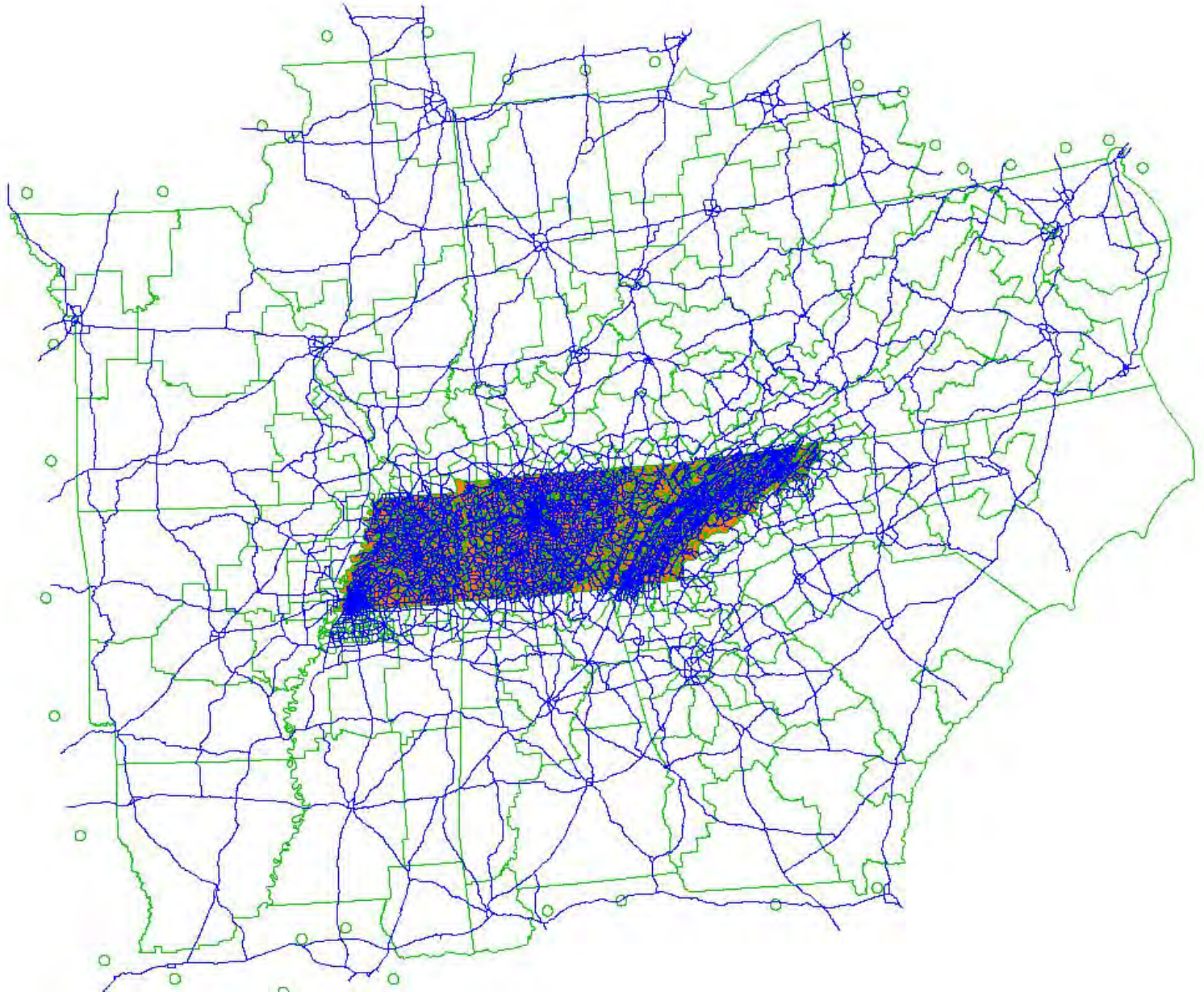
Zone Size and Network Coverage

	Ohio	Iowa	Indiana	Tennesse v1	Tennessee v2
Population	11,500,000	3,100,000	6,500,000	6,500,000	6,500,000
Road Miles*	42,000	45,000	19,000	9,421	32,546
TAZ in state	3,660	1,866	4,690	1,222	3,293
Total TAZ	5,116	3,314	4,831	1,397	3,684
Pop / TAZ*	3,200	1,600	1,400	5,300	2,000
Acres / TAZ*	12.2	30.2	7.8	34.5	12.8
Miles / Acre	0.9	0.8	0.5	0.2	0.8
Pop / Miles	270	70	340	690	200
Miles / TAZ	11.5	24.1	4.1	7.7	9.9

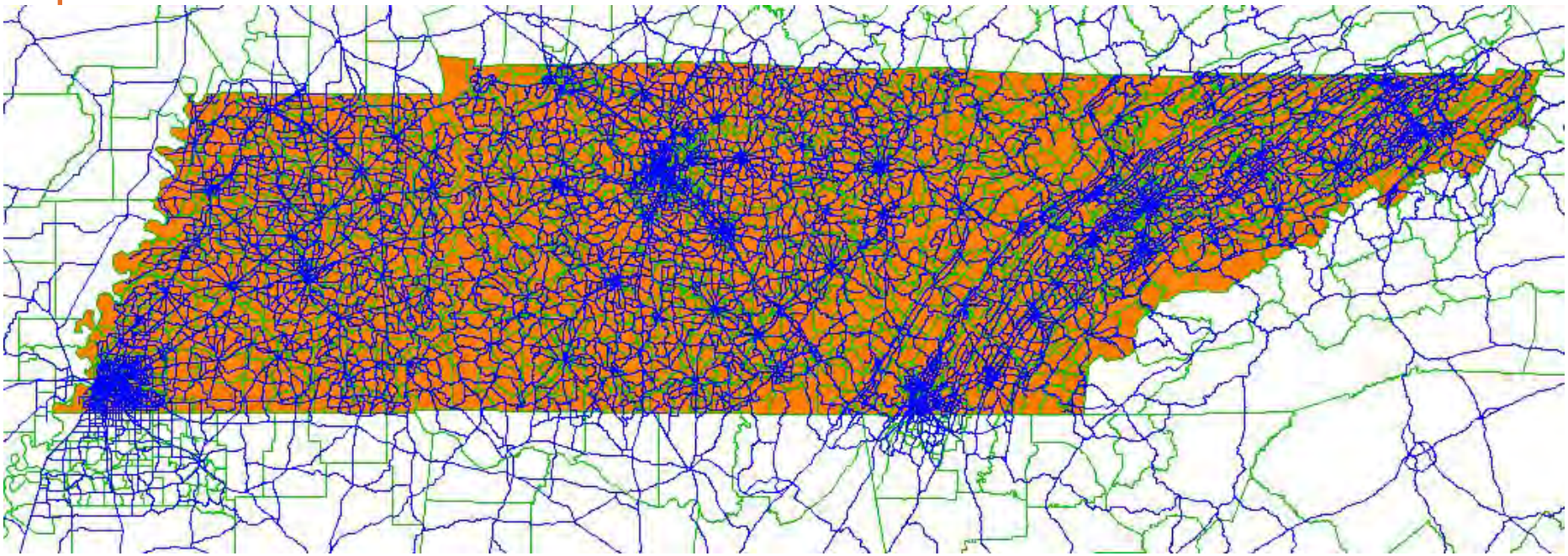
*in state

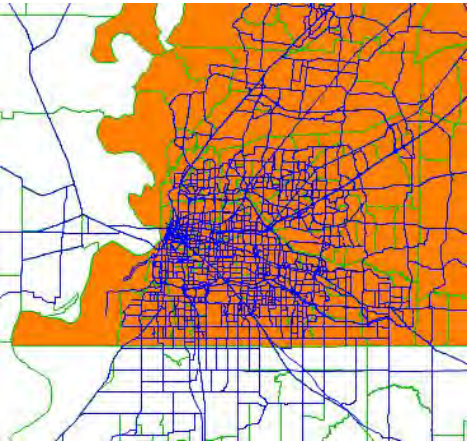
- New model has **triple** the network and zones

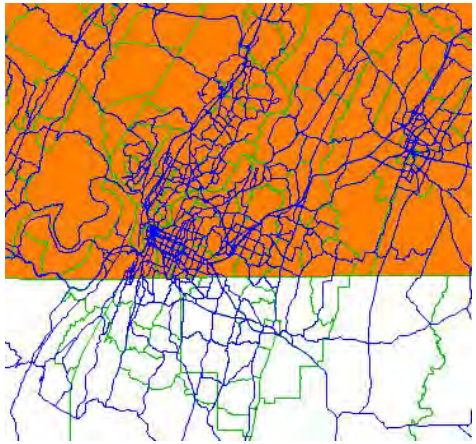
Version 2 Network and Zones

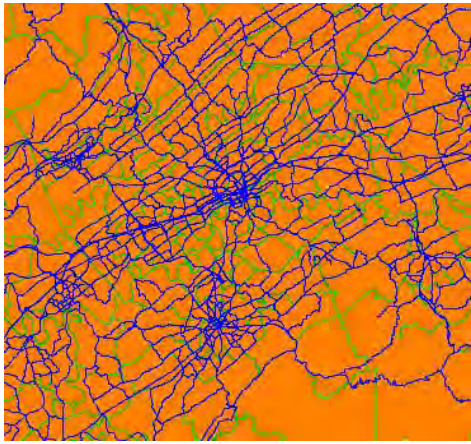


Version 2 Network and Zones

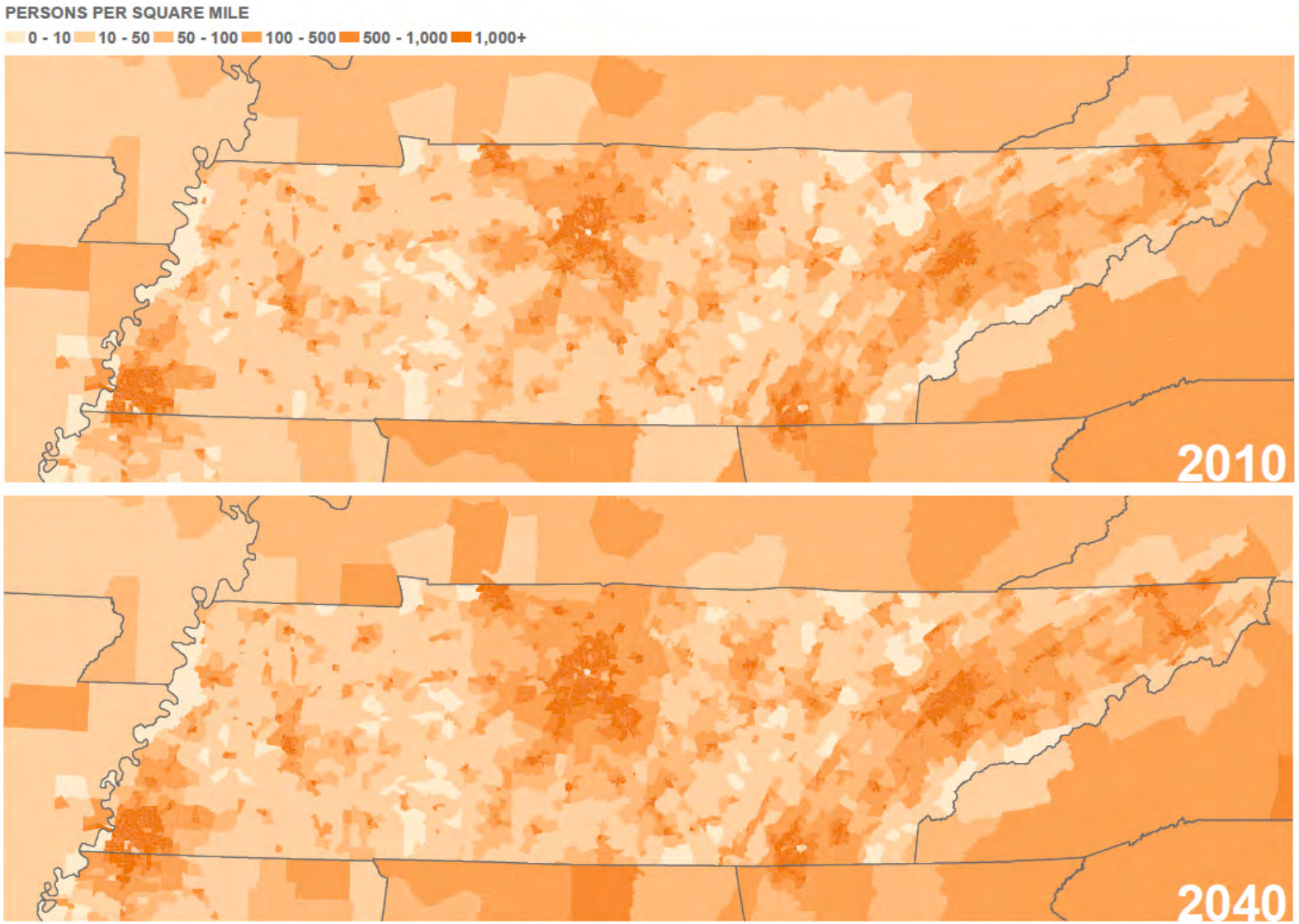




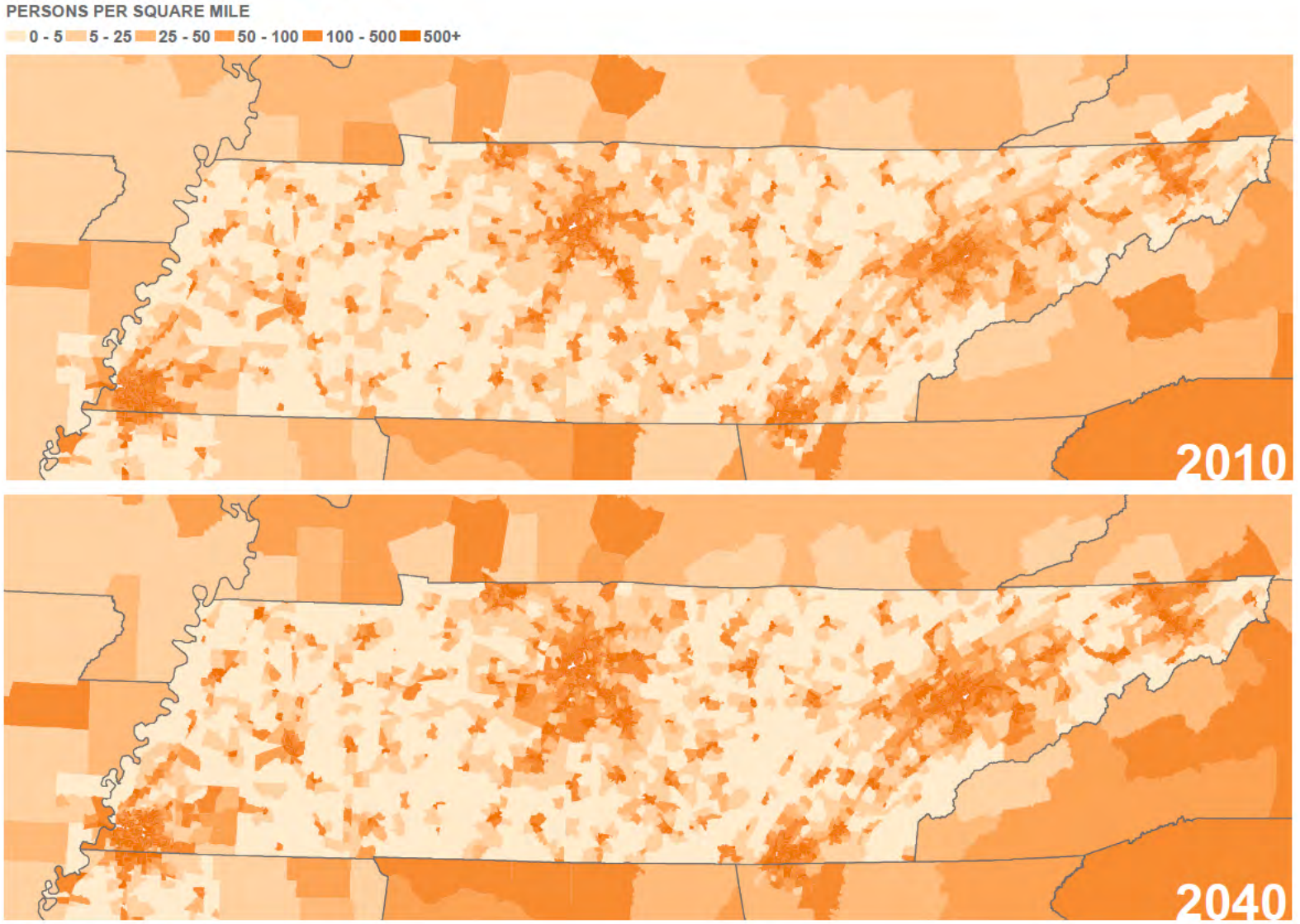




Population Density



Employment Density



Phase 2: Overview

Phase 2 Overview

Goal

- Validate a working model to produce forecasts and performance measures to support statewide planning in fall of 2014

Version 2 Model

- Simple 3-step model pivoting off of ODME
- Advanced components (destination choice, commodity flows, etc.) deferred to Phase/Version 3 in order to meet TDOT planning schedule

Phase 2 Overview

Phase 2 Process

- Highway Network Validation
  - Highway Network QA/QC
  - Highway Network Simplification
  - Highway Network Pre-Processing
  - 5-Year Historical Count Database
- Demand Data and Models
  - Quick-response Methods
  - Data-driven Methods
- Post-processing
  - Accessibility measures

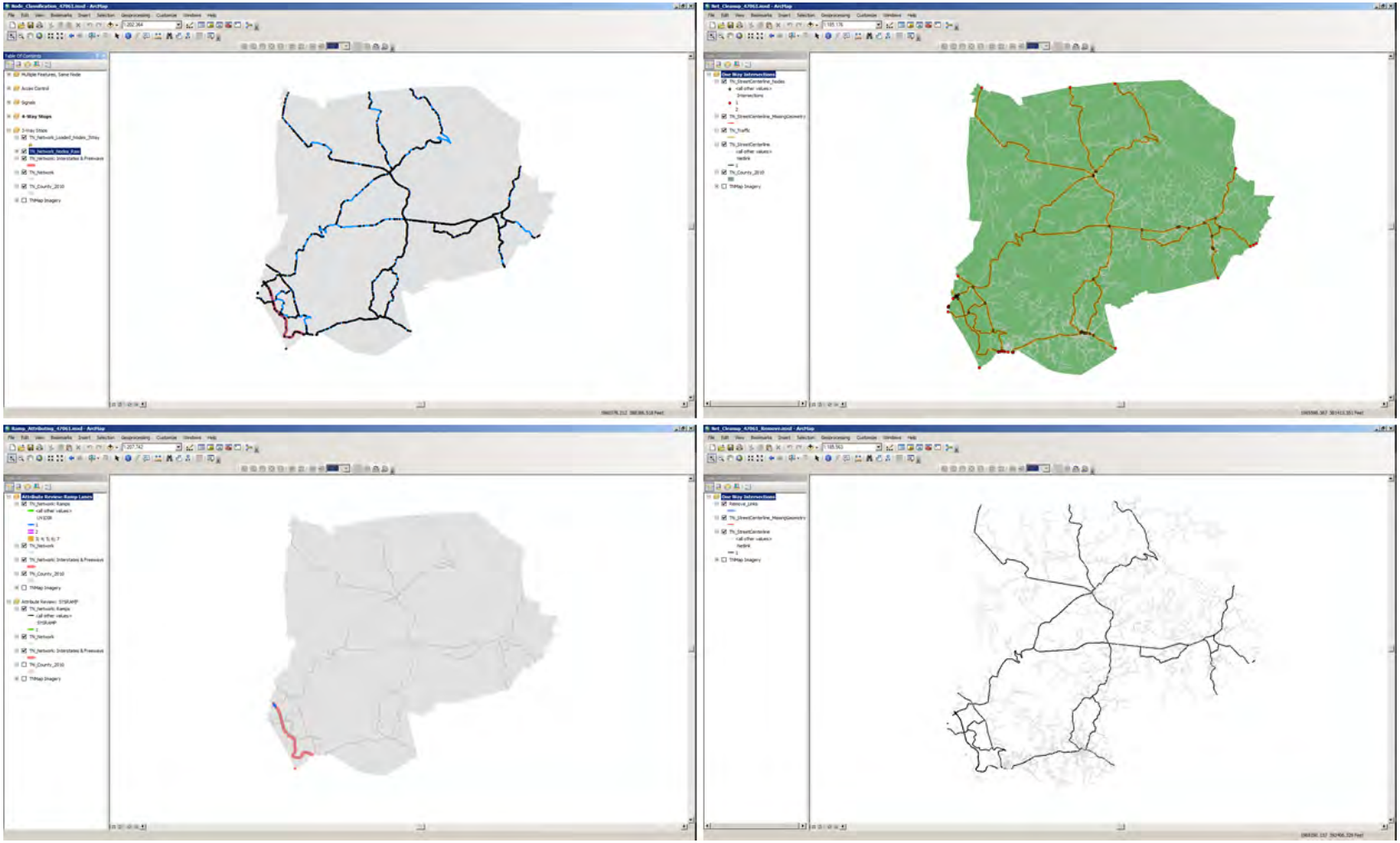
Phase 2: Highway Network Validation

Highway Network QA/QC

- Highway network developed in Phase-1 underwent county-level cleaning, quality assurance and quality control (*all 95 counties*)
- Generic facility type identification to support TRIMS attribute data transfer was checked/revised; Data transfer is performed sequentially
  - Interstate, Arterial, Collector, Local, Ramp (1s & 0s)
- Critical link attributes transferred from TRIMS were checked/revised; Attributes critical to the speed/capacity algorithms used by the model

- One-way Facilities	- Number of Lanes
- Access Control	- Posted Speed
- Divided Facility	- Intersection Control Type

Highway Network QA/QC



Highway Network Simplification

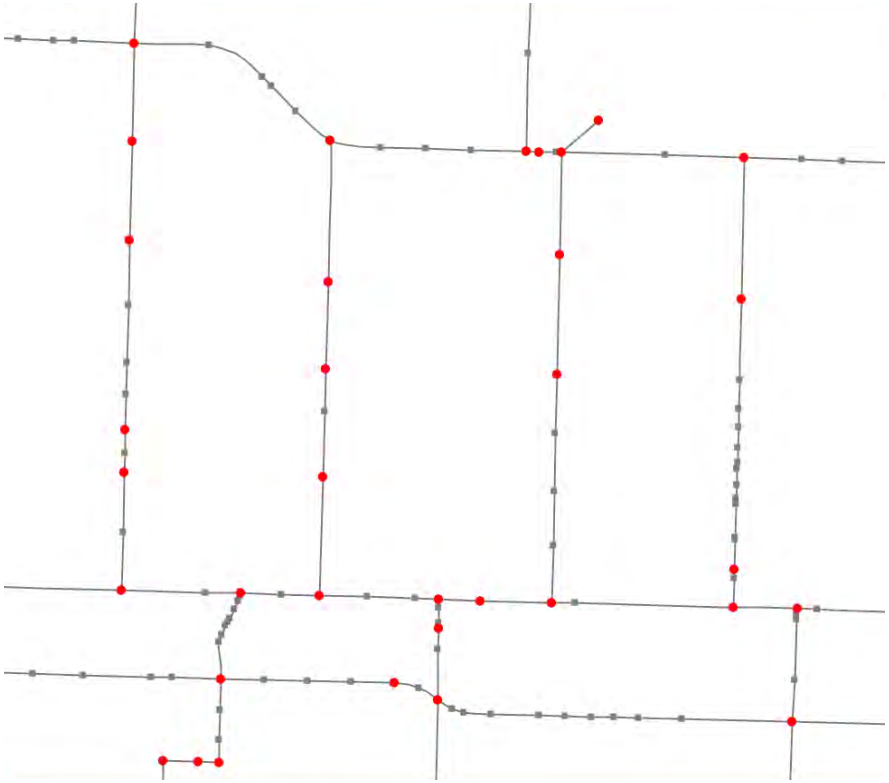
- Statewide Model Highway Network was built from an **all-streets** centerline database
- The highway network therefore contained thousands of 'pseudo-nodes' that can be eliminated
  - Reduce network size and complexity
  - Reduce eventual model run times
- Links / nodes are preserved based on user-specified list of attributes
  - If Lanes=2 on one side of pseudo-node and Lanes=3 on other side of pseudo-node → node and both link segments are retained
  - If Lanes=2 on one side of pseudo-node and Lanes=2 on other side of pseudo-node and all other attributes are identical → node is eliminated and link segments are combined to create one link
  - 30 different link and node attributes are used for specifying the preservation rule sets and merge criteria

Highway Network Simplification

Raw Unsimplified Network	Links	Nodes
Internal to TN	363,331	351,023
External to TN	28,165	27,374
Total	391,496	378,397

Final Simplified Network	Links	Nodes
Internal to TN	120,479	108,171
External to TN	9,729	8,938
Total	130,208	117,109

Network Reduction	***67%***	***69%***



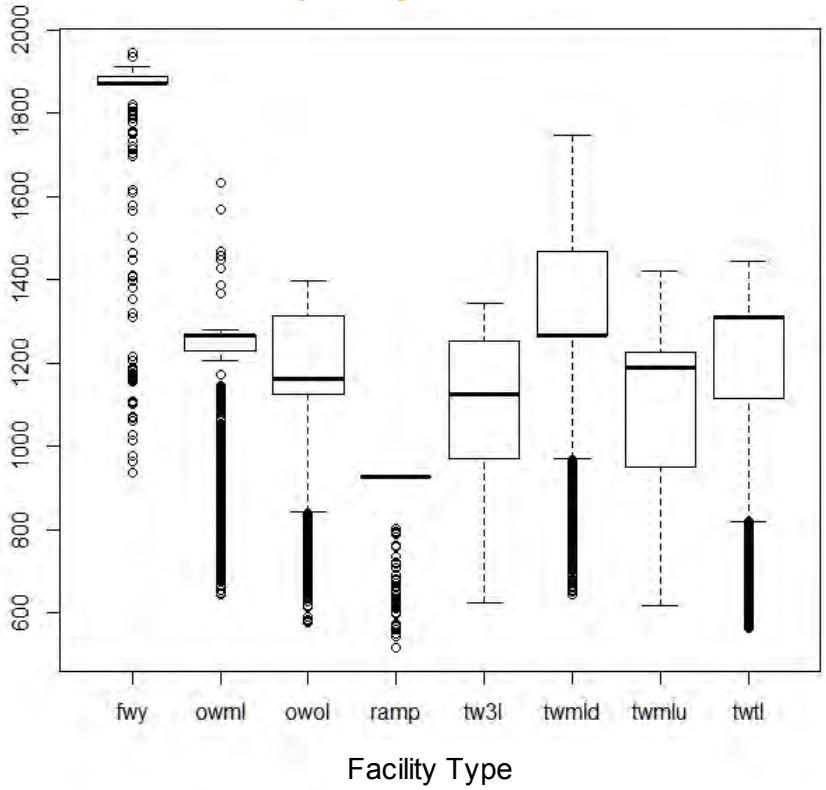
Gray = roadway links
Gray Nodes = Eliminated pseudo-nodes
Red Nodes = Retained nodes

Highway Network Pre-Processing Speeds & Capacities

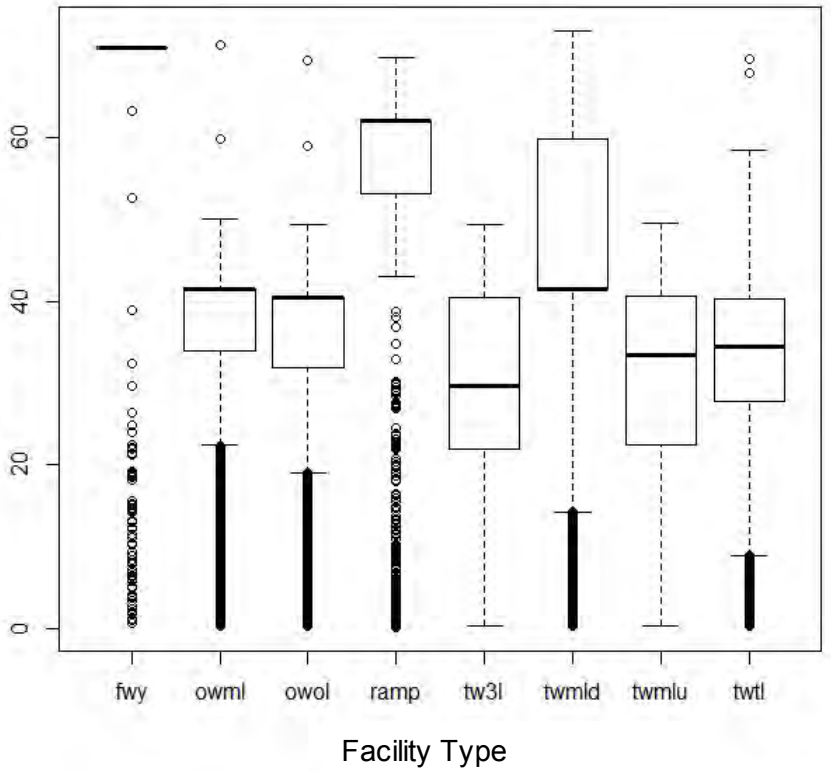
- Develop automated GISDK script to estimate link travel speeds and capacities; values are appended to highway network
- Using link / node attributes, the algorithm derives:
  - Free-flow travel speed (*by directional link AB/BA*)
  - Uniform control delay (*by directional link AB/BA*)
  - Free-flow Travel time (*by directional link AB/BA*)
  - Peak Hour Capacity Per Lane (*on each link*)
  - AM Period Total Capacity (*by directional link AB/BA*)
  - PM Period Total Capacity (*by directional link AB/BA*)
  - OP Period Total Capacity (*by directional link AB/BA*)

Highway Network Pre-Processing Speeds & Capacities

AM Hourly Capacities



AM Hourly Speeds



5-Year Historical Count Database

- RPM provided RSG with TDOT Historical Count database (TrfcHist.shp)
- Point shapefile database which contains AADT from 1983 thru 2013 for 12,297 STATION_IDs through the state of TN
- Data cleaning, quality assurance and quality control procedures were applied to develop 5-YR historical count database for the purposes of interim model origin-destination matrix estimation (ODME) and network assignment validation purposes
- AADTs on TRIMS (vintage 2012) are not appropriate for validation purposes; We need each count used only once, preferably at/near the precise location of the station counter. (We will use AADTS on all counts for post-processing.)
  - If TRIMS line layer AADTs were used, we'd have AADT values on almost every single link in the entire network
  - Using the historical point layer, we end up with AADT values on approx. 12,000 links only; the count coverage is still fantastic however (*by function class and spatially*)
- Selecting 2010 AADTs for ODME and model validation purposes is somewhat arbitrary
- Derive a 5-year average for modeling purposes

5-Year Historical Count Database Data Cleaning Procedures

FIRST, THROW OUT ANY BAD YEARS

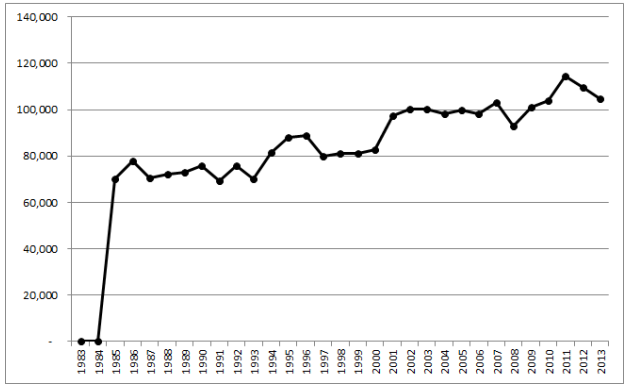
- For each station calculate front weighted mean
  - 2012 = 5 2011 = 4 2010 = 3 2009 = 2 2008 = 1
- Compare each year's count with the weighted mean for possible removal
  - Volume < 1,000 - acceptable error = +/- 200%
  - Volume < 2,500 - acceptable error = +/- 100%
  - Volume < 5,000 - acceptable error = +/- 50%
  - Volume < 10,000 - acceptable error = +/- 25%
  - Volume < 25,000 - acceptable error = +/- 20%
  - Volume < 50,000 - acceptable error = +/- 15%
  - Volume > 50,000 - acceptable error = +/- 10%

SECOND, THROW OUT BAD / ERRATIC STATIONS

- Coefficient of Variation (CV) was calculated once all the outlier AADTs for each station and each year had been removed.
- For stations with only 2012 data, Coefficient of Variation (CV) was calculated by adding the year 2013 data.
- Stations were dropped if CV was > 15% and if standard deviation was > 100.

5-Year Historical Count Database

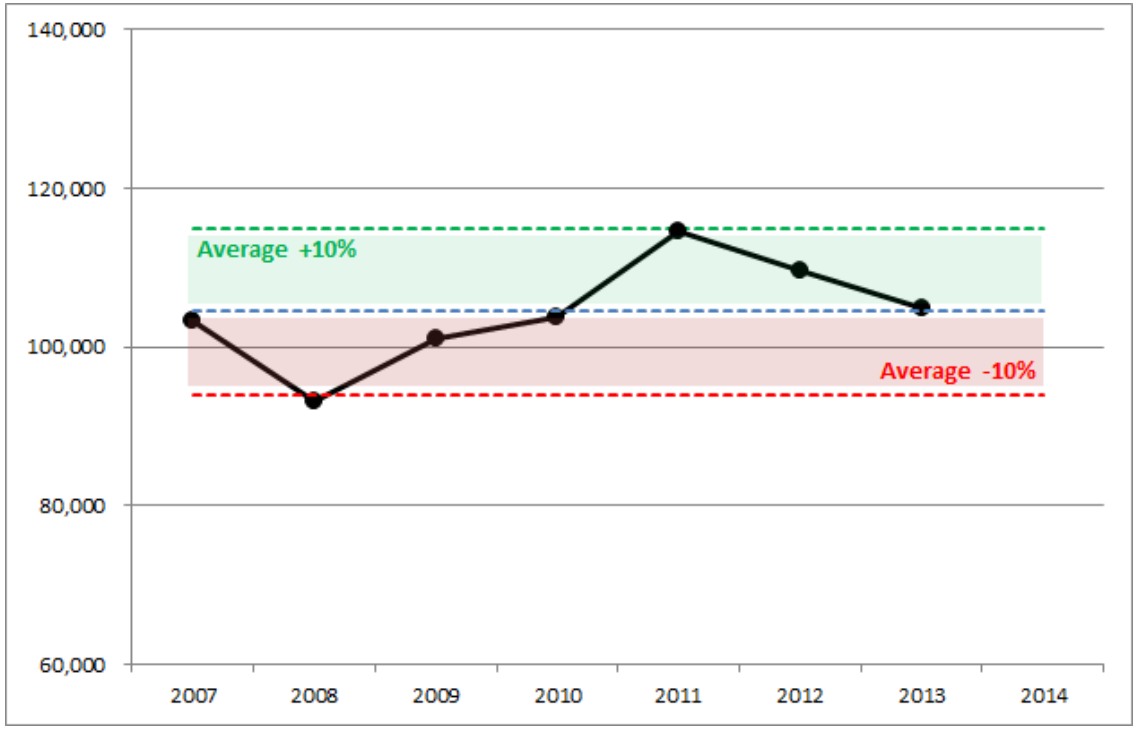
30-year AADT profile



A total of 213 stations were removed (out of 12,297) due to this process as either being outliers or otherwise suspicious data

Will use min, max, mean, median (ignoring outliers)

STATION_ID = 37000317; I-40 in Davidson County



Volumes on this segment of I-40 have varied +/- 10% over the last five years

Phase 2: Demand Data and Models

Phase 2 Demand Approach

DATA-DRIVEN METHODS

- *Use models to forecast change – use data to create the baseline*
- Two basic methods:
  - Use actual OD data if available
  - Use count data to adjust and scale demand (ODME)
- New opportunities from new "Big Data" sources
- Long standard overseas (required in UK)
- Also common in (even advanced) statewide models in US (e.g., FL, IN)
- Increasingly preferred by FTA for transit forecasting

QUICK-RESPONSE METHODS

- Could be implemented quickly to meet TDOT planning schedule
- Used to generate seed demand where actual demand data was not available
- Used to pivot off of ODME to introduce basic sensitivity in forecasts

Seed Trip Table Preparation

DATA-DRIVEN METHODS

- Home-Based Work (HBW) - *LEHD*
- Multi-Unit Truck - *ATRI GPS data*

QUICK-RESPONSE METHODS

- Home-Based Other (HBO)
- Non-home Based (NHB)
- Business (*long-distance*)
- Personal (*long-distance*)
- Personal Business (*long-distance*)
- Single Unit Truck (SUTrk)

Purpose	Total Trips	Rate per HH
HBW	99,337,750	2.49
HBO	179,984,100	4.51
NHB	77,208,785	1.93
BUSINESS	341,496	0.01
PERSONAL	939,299	0.02
PERSONAL_BUSINESS	237,229	0.01
SU_TRUCK	7,170,077	0.18
SUB-TOTAL	**356,828,590**	**8.93**

Purpose	Total Trips	Rate per HH
PASSENGER VEHICLES	232,551,496	5.82
TRUCKS (SU + ATRI)	8,738,329	0.22
TOTAL	**241,289,825**	**6.04**

All Zone (Category 1-2-3-4-5)

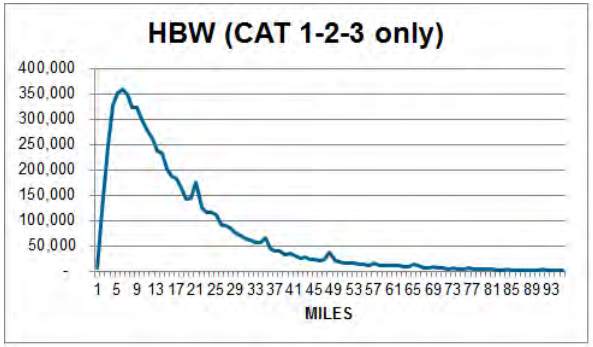
Quick Response Methods

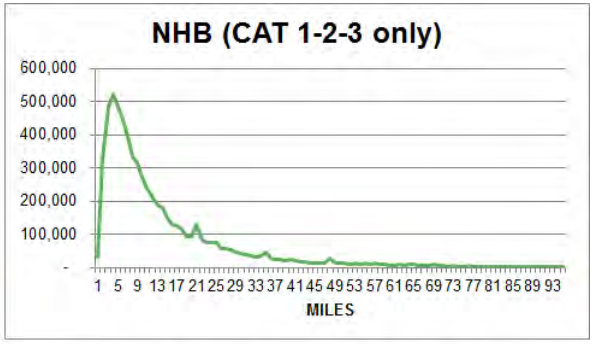
- Quick response methods based on
  - NCHRP Report #365 - Travel Estimation Techniques for Urban Planning
  - NCHRP Report #716 - Travel Demand Forecasting: Parameters and Techniques
  - NCHRP Report #735 - Long-Distance and Rural Travel Transferable Parameters for Statewide Travel Forecasting Models
- NCHRP Report methods / parameters utilized for performing:
  - Trip Generation
  - Trip Distribution
  - PA2OD Conversion
  - Person-to-Vehicle Trip Conversion

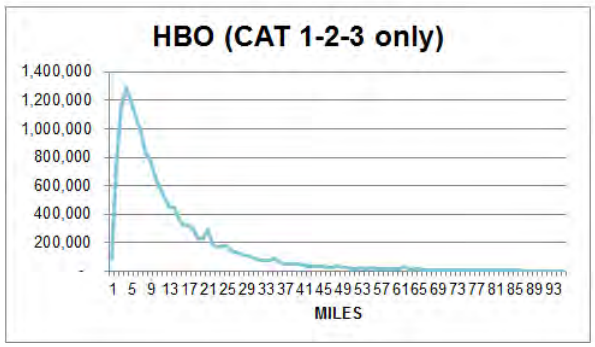
Seed Trip Table Preparation – Trip Distribution

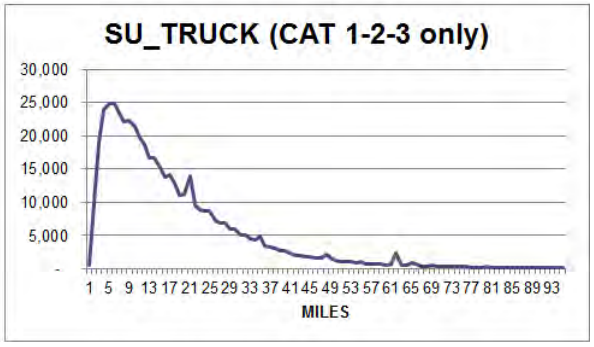
Purpose	Average Trip Length (miles)
HBW	20.5
HBO	15.8
NHB	16.9
BUSINESS	178.3
PERSONAL	169.8
PERSONAL_BUSINESS	169.5
SU_TRUCK	20.5
SUB-TOTAL	27.6

Type	Average Trip Length (miles)
PASSENGER VEHICLES	24.3
TRUCKS (SU + ATRI)	49.5
TOTAL	25.6









Development of LEHD Flow Matrix

- A data-driven HBW portion of the seed trip table was prepared
- Census Longitudinal Employer-Household Dynamics (LEHD) makes several data products available that may be used to characterize workforce dynamics
  - Origin-Destination Employment Statistics (LODES); Version 7 of LODES was enumerated by 2010 census blocks.
  - Data files are state-based and organized into three types: Origin-Destination (OD) all at census block geographic detail.
- An LEHD-based worker flow origin-destination matrix was prepared using the TAZ structure developed in Phase-1 (approx 4,000 zones representing 17 states and D.C.)

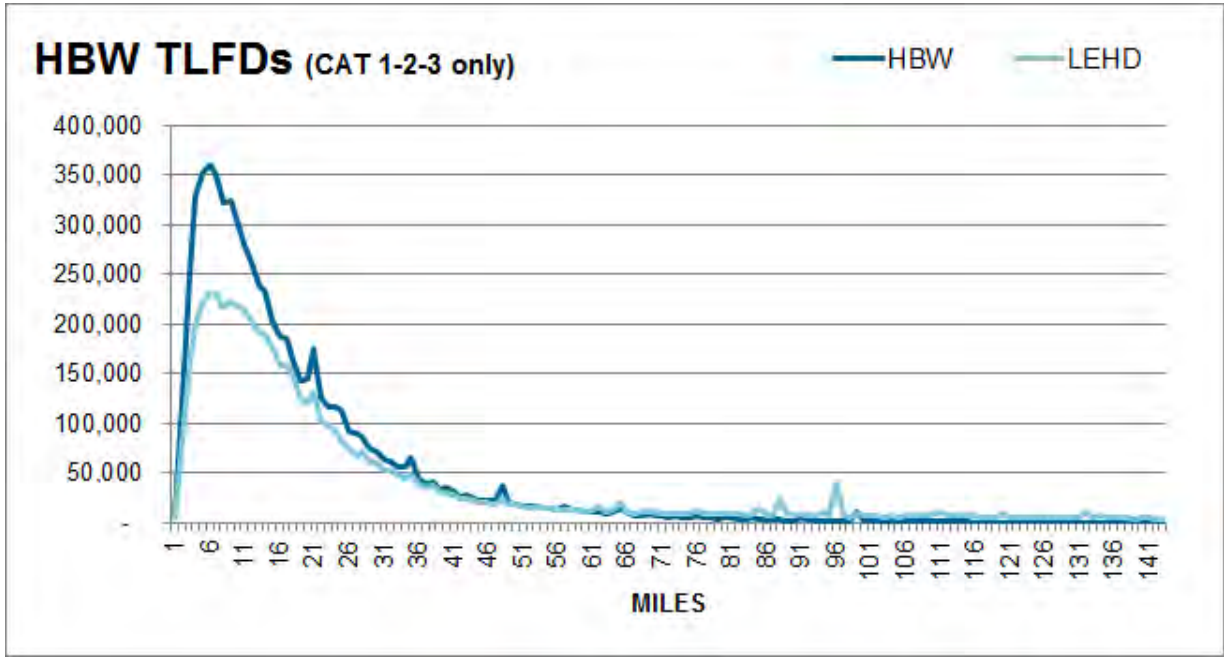
United States™ Census Bureau

Development of LEHD Flow Matrix

LEHD "trips" are longer partly because the Census data *includes* long-distance work trips;

These trips supplement the long distance "Business" trips estimated using quick response methods

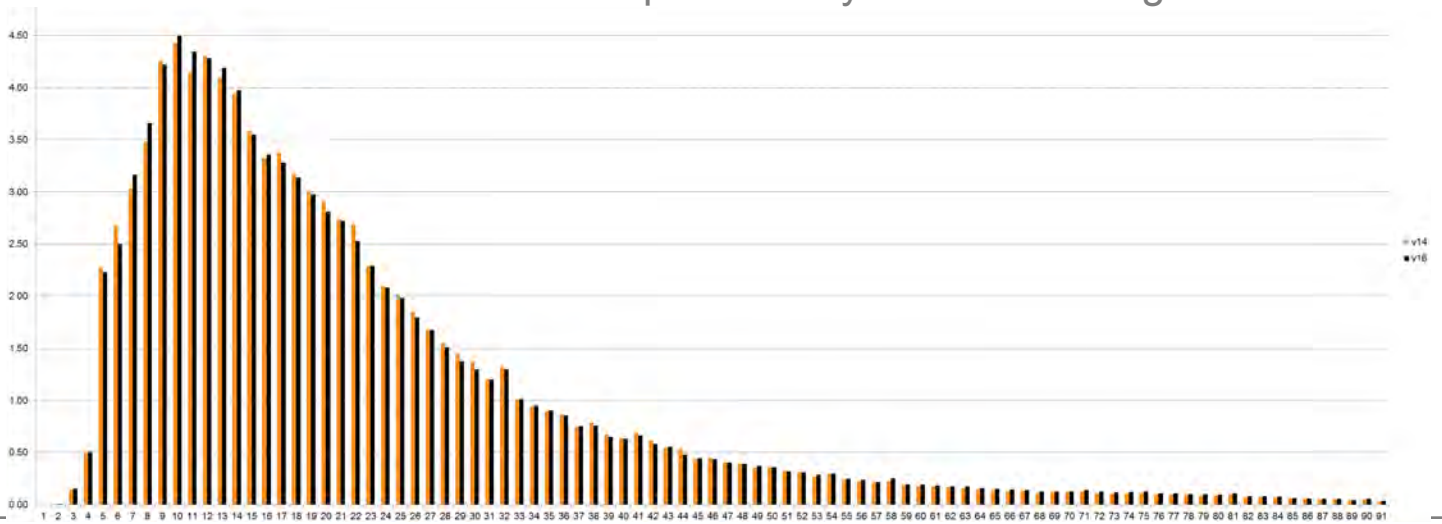
Purpose	Total Trips	Rate per HH	Average Trip Length (miles)
HBW	99,337,750	2.49	20.48
LEHD_HBW	90,947,604	2.28	38.91



ODME Process

Combination of Custom and 'Canned' Procedures

- Process
  - Custom ODME of Truck Assignment
  - Initial ODME of Auto Assignment with Custom Heuristic
  - Final ODME of Auto Assignment with TransCAD's Multiple Path algorithm
- Issues
  - Canned procedures are not always what is desired
  - TC's Single and Multiple Path algorithms allow major distortions to Ods
  - TC's Gradient Method is not computationally feasible for large models



Current ODME Results

TYPE	ITEM	NUMOBS	AVGCNT	AVGMOD	AVGERR	PCTERR	CORRCOEF	MAPE	PCTRMSE	STANDARD
Total	**All**	**12690**	**6794.08**	**6889.17**	**95.09**	**1.40**	**0.96**	**51.5**	**45.6**	**60.0**
Functional Class	R. Interstate (1)	271	17768.52	21530.09	3761.57	21.17	0.96	22.9	25.2	
Functional Class	R. Prin. Arterial (2)	756	6089.74	7490.11	1400.37	23.00	0.91	45.4	36.1	
Functional Class	R. Minor Arterial (6)	954	4421.81	4237.77	-184.04	-4.16	0.89	26.8	33.3	
Functional Class	R. Major Collector (7)	1494	1984.41	1956.11	-28.30	-1.43	0.85	44.1	55.7	
Functional Class	R. Minor Collector (8)	2804	868.12	684.23	-183.88	-21.18	0.57	77.3	125.7	
Functional Class	R. Local Road (9)	35	965.91	192.17	-773.74	-80.10	0.62	127.4	104.2	
Functional Class	U. Interstate (11)	440	42875.62	44678.37	1802.75	4.20	0.90	17.1	20.7	
Functional Class	U. Other Freeway (12)	193	20383.25	21766.70	1383.45	6.79	0.94	21.1	22.6	
Functional Class	U. Prin. Arterial (14)	1541	13515.56	13290.53	-225.03	-1.66	0.90	23.8	28.5	
Functional Class	U. Minor Arterial (16)	2100	7910.63	7928.85	18.22	0.23	0.83	43.4	44.3	
Functional Class	U. Collector (17)	2001	3292.95	2930.46	-362.49	-11.01	0.69	75.9	87.9	
Functional Class	U. Local Road (19)	94	2838.45	1687.91	-1150.54	-40.53	0.65	92.9	95.8	
Volume Group 0	< 5,000 AADT	7333	1672.86	1605.95	-66.92	-4.00	0.63	68.8	101.1	**101.4**
Volume Group 1	5,000 to 10,000 AADT	1944	6305.91	6375.82	69.91	1.11	0.49	38.6	47.6	**56.3**
Volume Group 2	10,000 to 20,000 AADT	1702	10555.10	10525.59	-29.51	-0.28	0.73	24.8	32.3	**51.4**
Volume Group 3	20,000 to 30,000 AADT	747	15762.25	15691.99	-70.26	-0.45	0.78	20.3	27.0	**35.7**
Volume Group 4	30,000 to 40,000 AADT	317	20166.21	21511.16	1344.95	6.67	0.72	19.5	24.9	**32.0**
Volume Group 5	> 40,000 AADT	660	38856.45	40728.49	1872.04	4.82	0.90	16.9	20.5	**21.6**
Area Type	Urban	6371	10534.89	10519.75	-15.13	-0.14	0.95	47.1	38.6	
Area Type	Rural	6314	3020.31	3228.97	208.67	6.91	0.96	55.9	53.3	
Classes	Freeways	711	33305.96	35855.32	2549.36	7.65	0.94	19.3	22.6	
Classes	Arterials	5544	9054.11	9205.92	151.81	1.68	0.91	34.6	35.9	
Classes	Collectors	6299	1903.18	1699.46	-203.72	-10.70	0.75	69.0	98.0	
Classes	Local	129	2330.40	1282.09	-1048.31	-44.98	0.67	102.3	102.1	

Phase 2: Post-processing

Overview of Accessibility Measures

Accessibility measures for various **Points of Interest (POI)** in around the state are derived using network shortest path data (*skims*) and zonal socio-economic data (*population & employment*)

The **Points of Interest** include:

- Commercial Airports with annual passengers > 10,000
- Hospitals with Level I Trauma Centers
- Intermodal Facilities in TN
- Park and Ride Facilities in TN
- State Universities in TN
- State and National Parks in TN

AIRPORTS – Selection Criteria

All major commercial airports inside and around TN that serve more than 10,000 passengers per day were selected; Eight (8) airports listed below

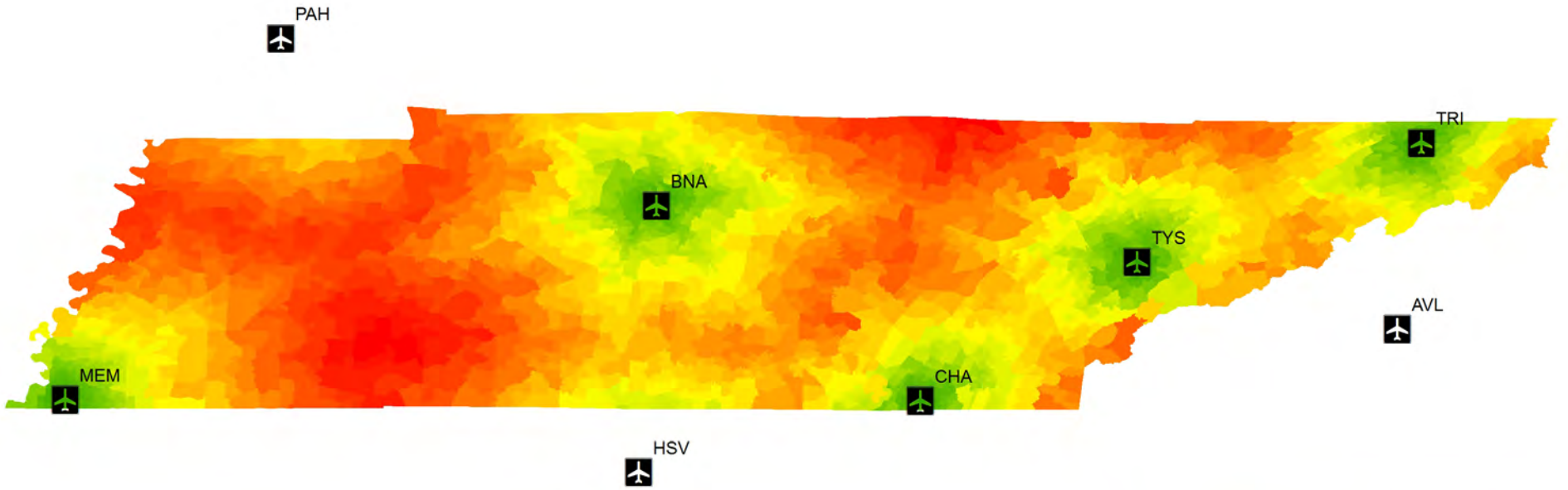
INSIDE TENNESSEE (5)

- TRI-CITIES REGIONAL AIRPORT (TRI)
- CHATTANOOGA METROPOLITAN AIRPORT / LOVELL FIELD (CHA)
- MCGHEE TYSON AIRPORT (TYS)
- MEMPHIS INTERNATIONAL AIRPORT (MEM)
- NASHVILLE INTERNATIONAL AIRPORT (BNA)

OUTSIDE TENNESSEE (3)

- HUNTSVILLE INTL-CARL T JONES FIELD (HSV)
- BARKLEY REGIONAL AIRPORT (PAH)
- ASHEVILLE REGIONAL AIRPORT (AVL)

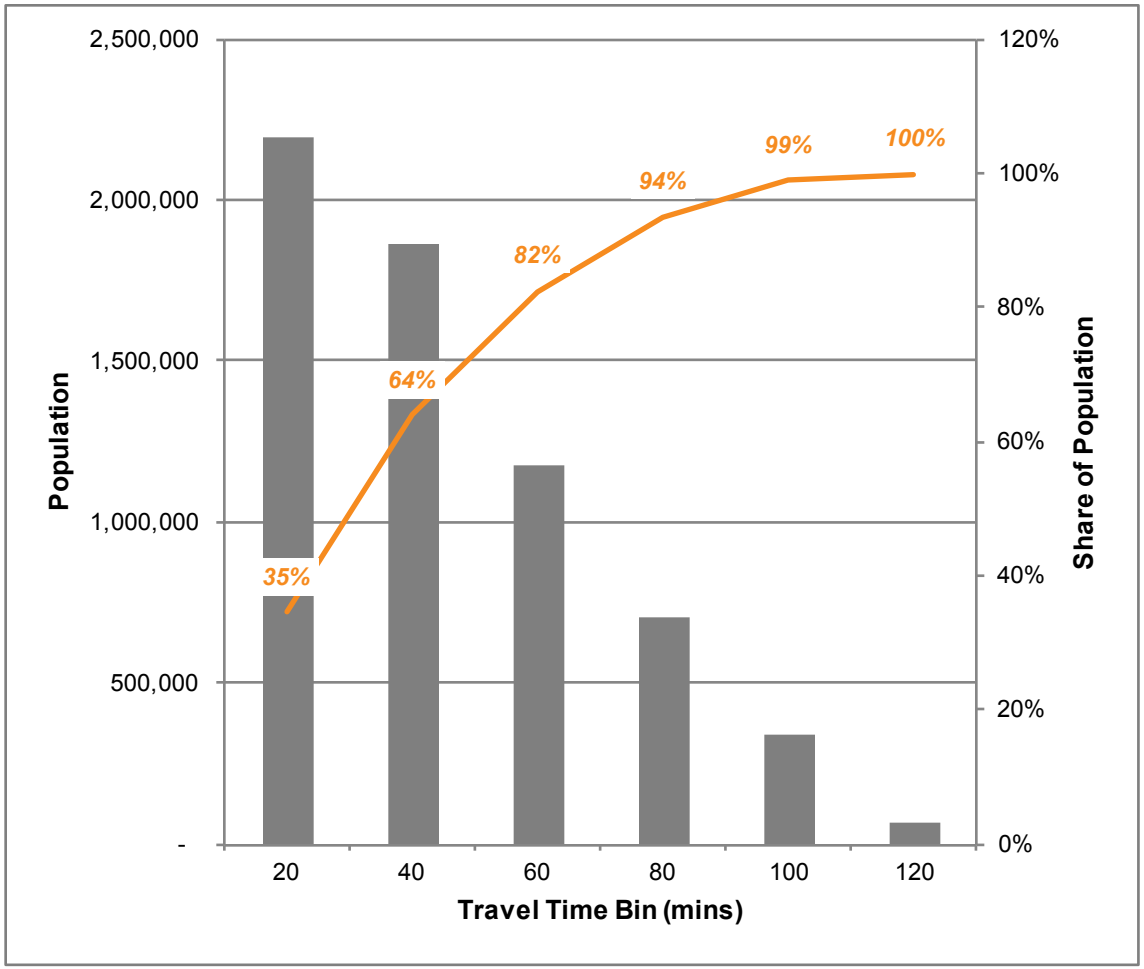
AIRPORT – Accessibility Map



- TRI-CITIES REGIONAL AIRPORT (**TRI**)
- CHATTANOOGA METROPOLITAN AIRPORT (**CHA**)
- MCGHEE TYSON AIRPORT (**TYS**)
- MEMPHIS INTERNATIONAL AIRPORT (**MEM**)
- NASHVILLE INTERNATIONAL AIRPORT (**BNA**)

- HUNTSVILLE INTL-CARL T JONES FIELD (**HSV**)
- BARKLEY REGIONAL AIRPORT (**PAH**)
- ASHEVILLE REGIONAL AIRPORT (**AVL**)

AIRPORT – Population Accessibility



Time Range		Population	% Share	Cum % Share
0	20	2,193,624	35%	35%
20	40	1,864,149	29%	64%
40	60	1,177,527	19%	82%
60	80	705,088	11%	94%
80	100	335,935	5%	99%
100	120	69,249	1%	100%

80% of the state's population is within a 1-hr drive of a major commercial airport

All of the state's population is within a 2-hour drive of a major commercial airport

HOSPITAL – Selection Criteria

All Level I Trauma Centers in and around TN were selected. The list was obtained from http://www.traumamaps.org/Trauma.aspx. There are seven (7) such hospitals and the list is presented below.

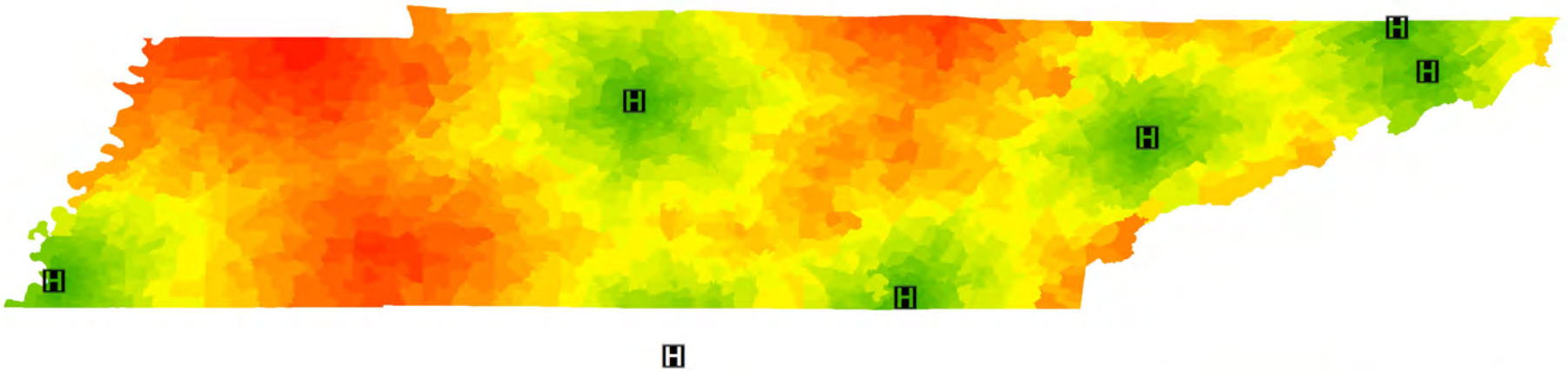
Inside Tennessee

- Regional Medical Center at Memphis
- Vanderbilt University Hospital
- Erlanger Hospital
- University of Tennessee Medical Center
- Johnson City Medical Center Hospital
- Holston Valley Community Hospital

Outside Tennessee

- Huntsville Hospital

HOSPITAL – Accessibility Map

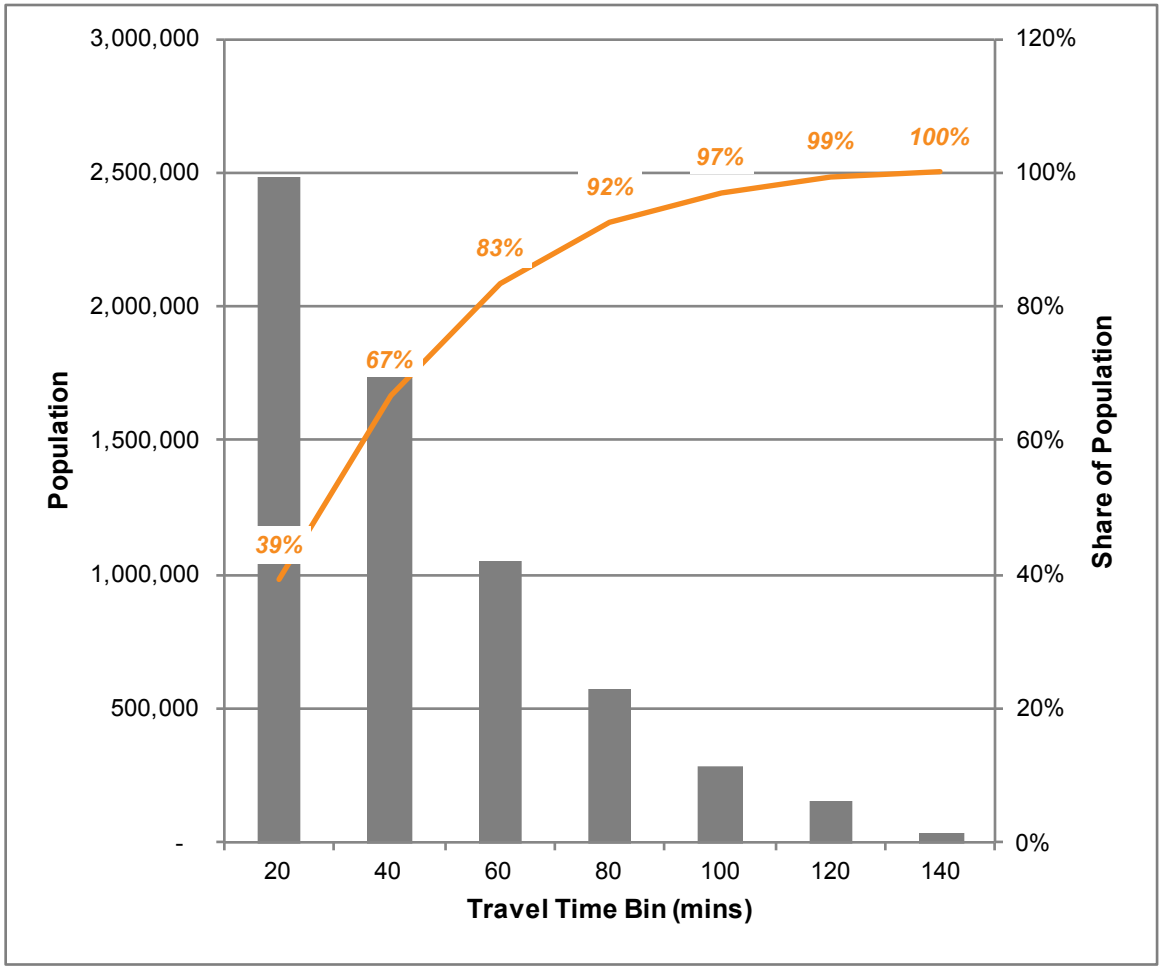


A **Level I** trauma center provides the highest level of surgical care to trauma patients. It has a full range of specialists and equipment available 24 hours a day and admits a minimum required annual volume of severely injured patients.

A **Level I** trauma center is required to have a certain number of the following staff on duty 24 hours a day at the hospital:

- surgeons
- emergency physicians
- anesthesiologists
- nurses
- an education program
- and preventive and outreach programs

HOSPITAL – Population Accessibility



Time Range		Population	% Share	Cum % Share
0	20	2,488,170	39%	39%
20	40	1,749,707	28%	67%
40	60	1,054,389	17%	83%
60	80	576,499	9%	92%
80	100	286,922	5%	97%
100	120	155,843	2%	99%
120	140	34,575	1%	100%

83% of the state's population is within a 1-hr drive of a major trauma center

Nearly all of the state's population is within a 2-hour drive of a major trauma center

INTERMODAL FACILITIES – Selection Criteria

All intermodal facilities in Tennessee were selected. There are 92 such facilities in the spatial data set that was supplied to RSG

MODE variable summary

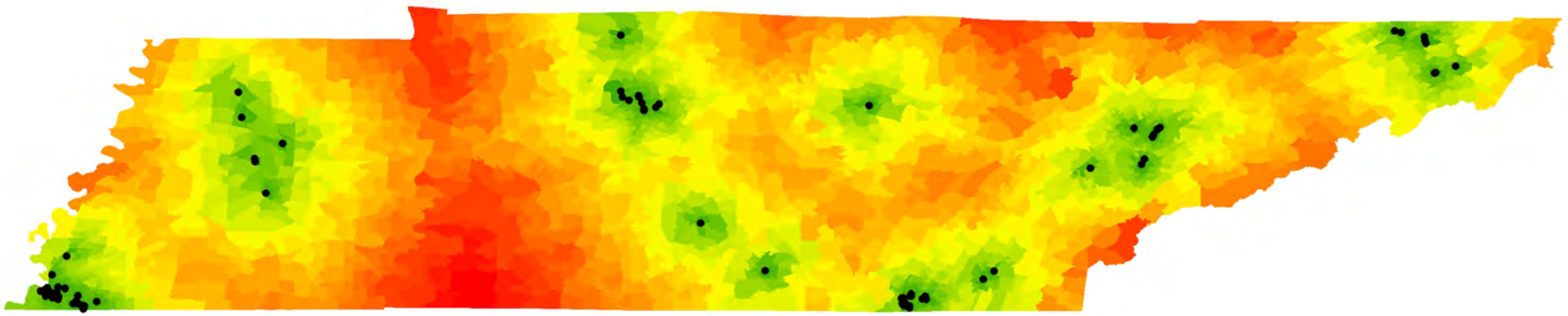
Labels	Count
AIR	10
INDEPENDENT PORT	3
PORT	1
RAIL	62
TRUCK	16
Grand Total	**92**

MODE TYPE variable summary

Labels	Count
AIR & TRUCK	10
PORT & TRUCK	1
RAIL & TRUCK	59
TRUCK - PORT - RAIL	19
TRUCK & TRUCK	3
Grand Total	**92**

Note, Memphis has the one PORT facility in the state on the Mississippi River

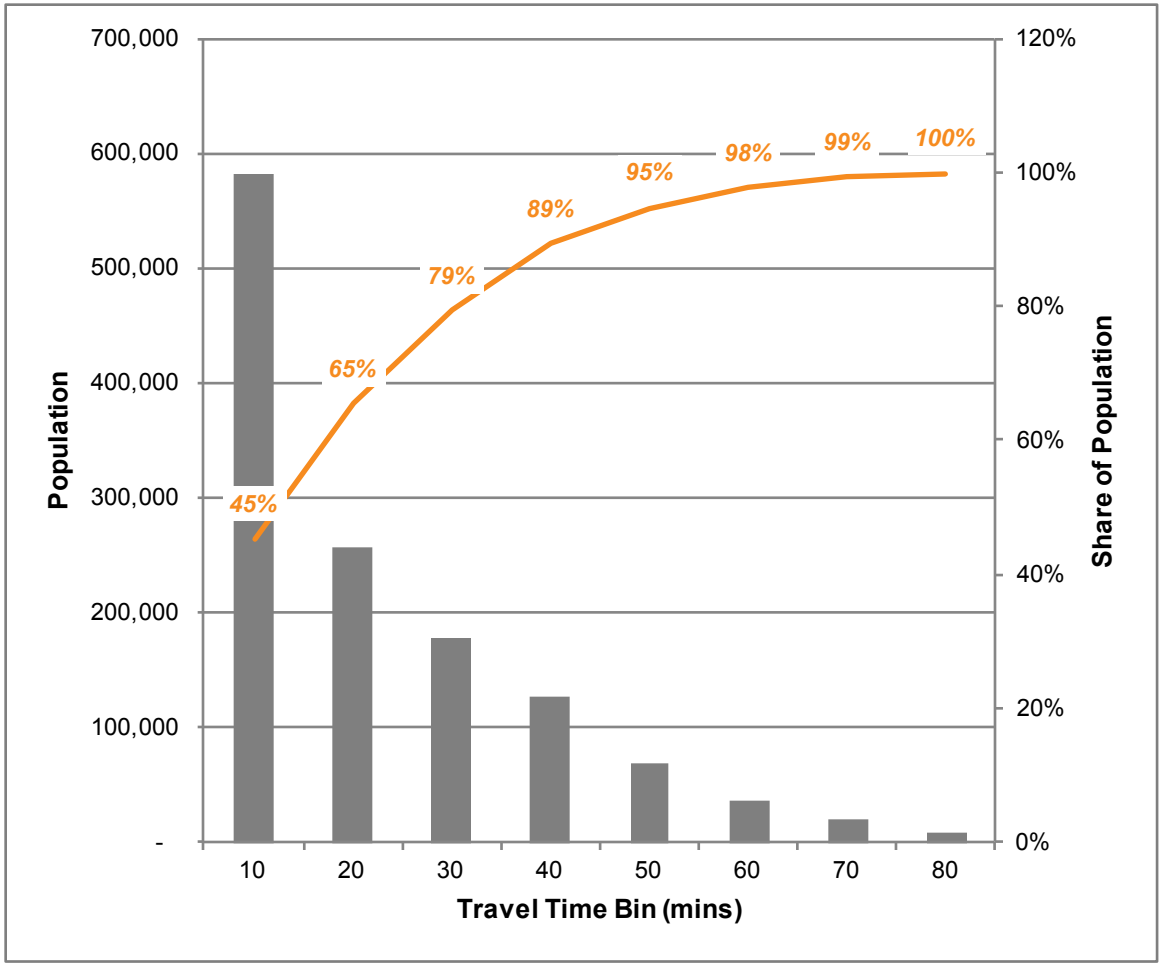
INTERMODAL FACILITIES – Accessibility Map



Phase-3 commodity flow modeling would provide a means to differentiate the intermodal destinations for a more refined examination of accessibilities by industry sector and intermodal facility type.

For this exercise we simply measure minimum travel time to each of the 92 intermodal facilities displayed here

INTERMODAL – Employment Accessibility

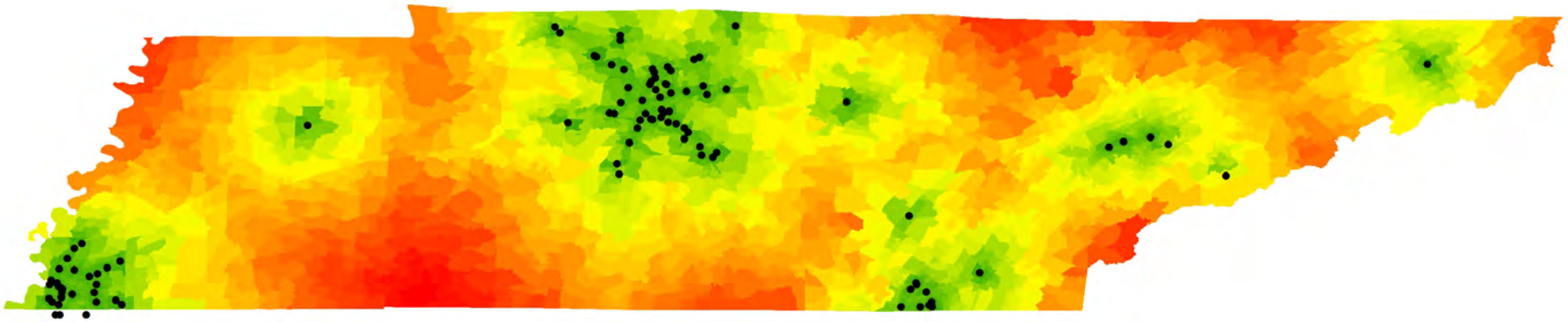


Time Range		EMP Goods Producing *	% Share	Cum % Share
0	10	580,589	45%	45%
10	20	257,479	20%	65%
20	30	178,569	14%	79%
30	40	127,688	10%	89%
40	50	69,889	5%	95%
50	60	37,409	3%	98%
60	70	20,885	2%	99%
70	80	7,610	1%	100%

80% of the state's goods producing employment * is within a 30-min drive of an intermodal facility

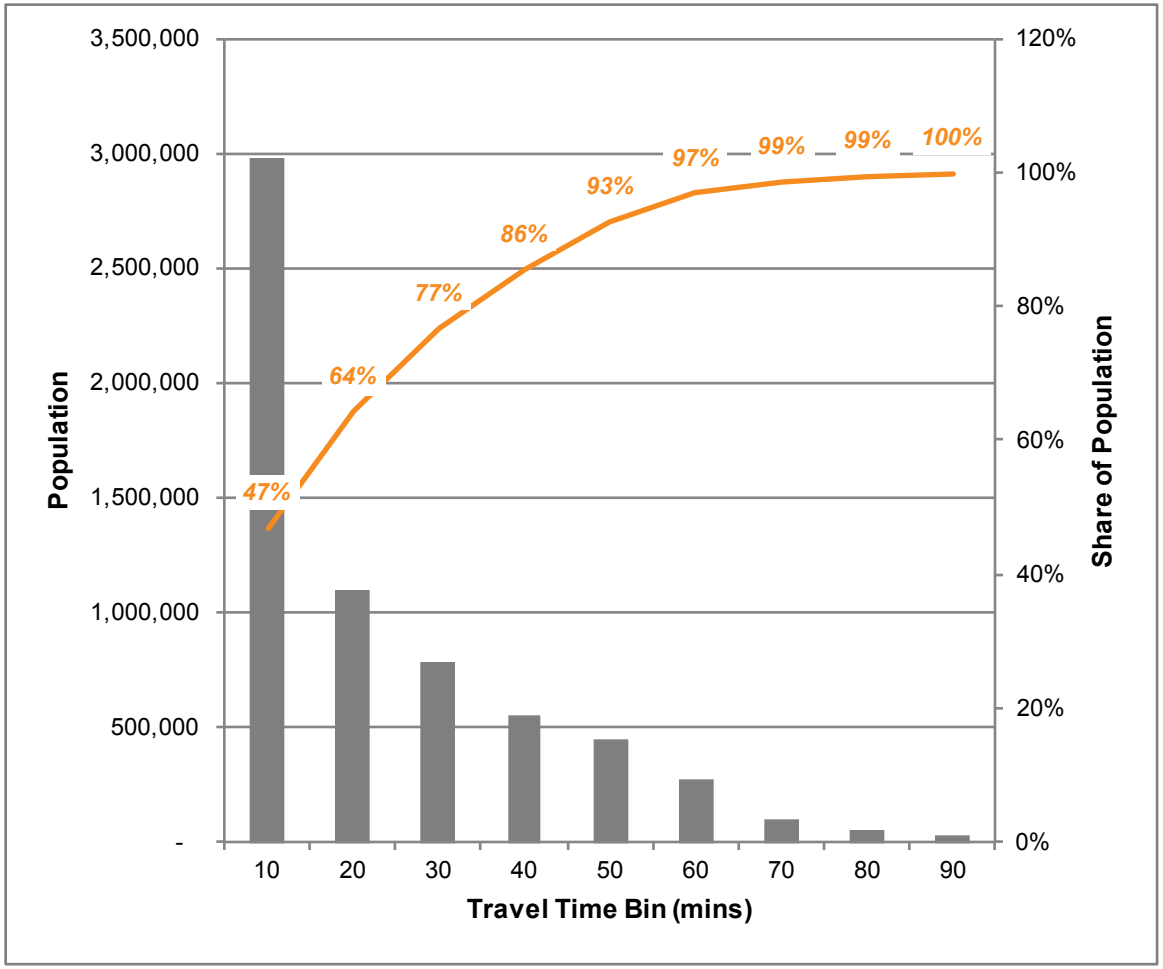
** Not service or retail employment*

PARK & RIDE – Accessibility Map



All **107** Park and Ride facilities in Tennessee were selected

PARK & RIDE – Population Accessibility

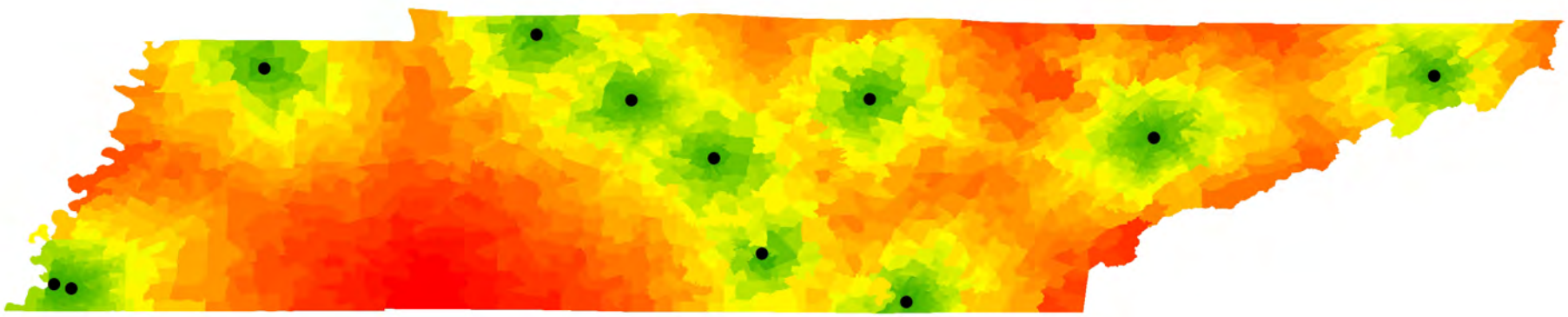


Time Range		Population	% Share	Cum % Share
0	10	2,981,253	47%	47%
10	20	1,097,841	17%	64%
20	30	788,995	12%	77%
30	40	556,298	9%	86%
40	50	449,334	7%	93%
50	60	270,371	4%	97%
60	70	106,927	2%	99%
70	80	59,608	1%	99%
80	90	28,217	0%	100%

Nearly half of the state's population is within a 10-minute* drive of a Park-n-Ride facility

** Zone-to-zone travel times that do not yet include the contribution of zone specific terminal times*

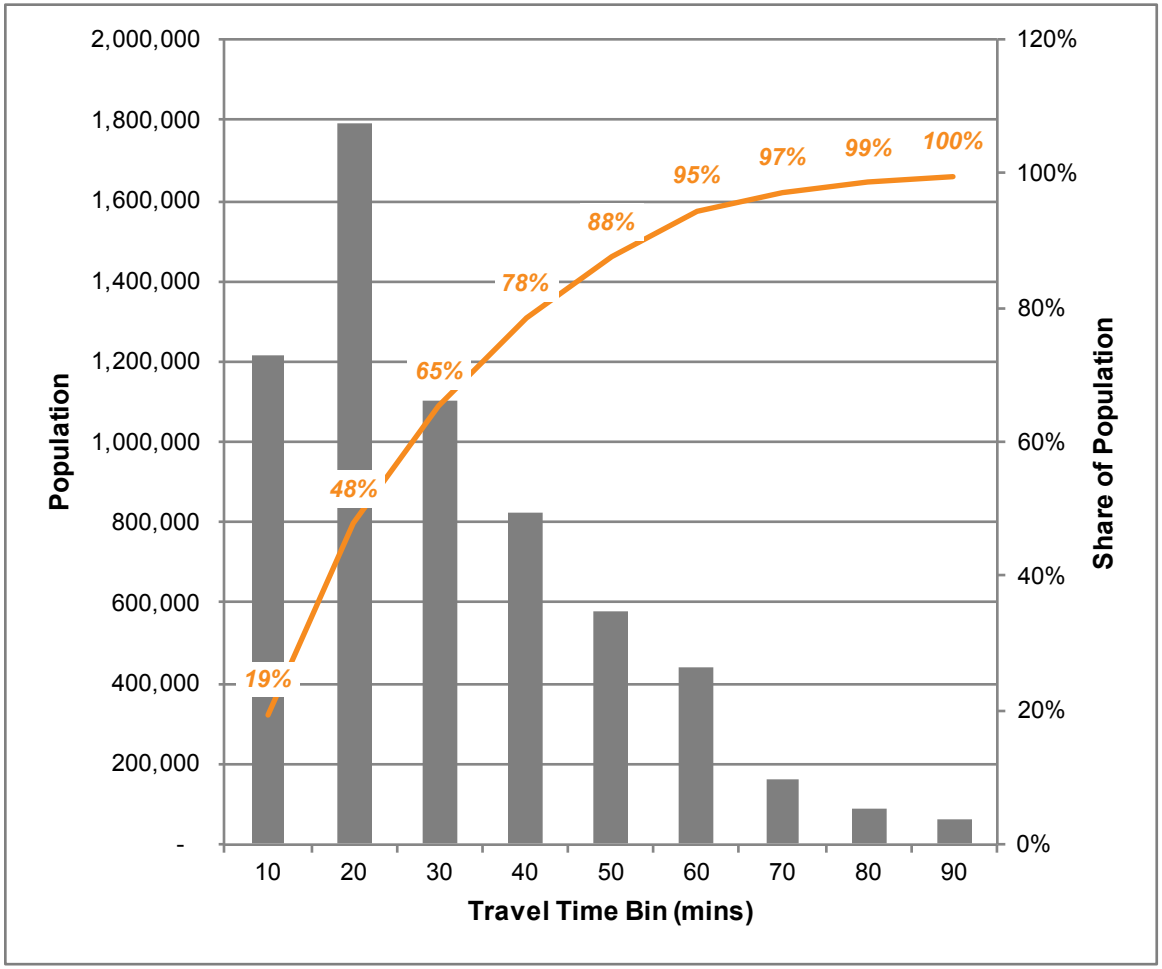
UNIVERSITIES – Accessibility Map



TN State University System

Austin Peay State University	Clarksville
East TN State University	Johnson City
Middle TN State University	Murfreesboro
TN State University	Nashville
TN Technological University	Cookeville
University of Memphis	Memphis
University of TN, Chattanooga	Chattanooga
University of TN, Knoxville	Knoxville
University of TN, Martin	Martin
University of TN Health Science Center	Memphis
University of TN Space Institute	Tullahoma

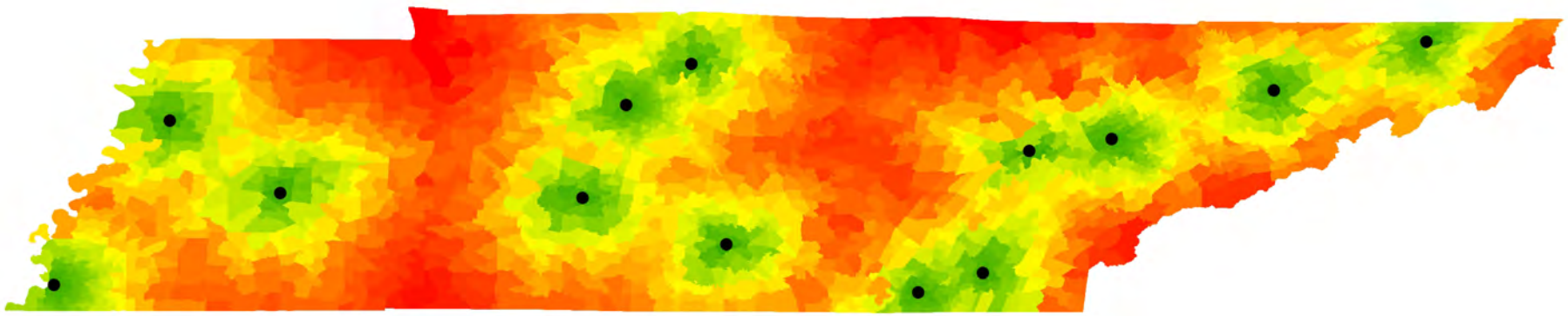
UNIVERSITIES – Population Accessibility



Time Range		Population	% Share	Cum % Share
0	10	1,214,915	19.3%	19%
10	20	1,793,519	28.5%	48%
20	30	1,102,966	17.5%	65%
30	40	824,172	13.1%	78%
40	50	581,072	9.2%	88%
50	60	440,876	7.0%	95%
60	70	163,918	2.6%	97%
70	80	90,754	1.4%	99%
80	90	60,687	1.0%	100%

65% of the state's population is within a 30-minute drive of a state university

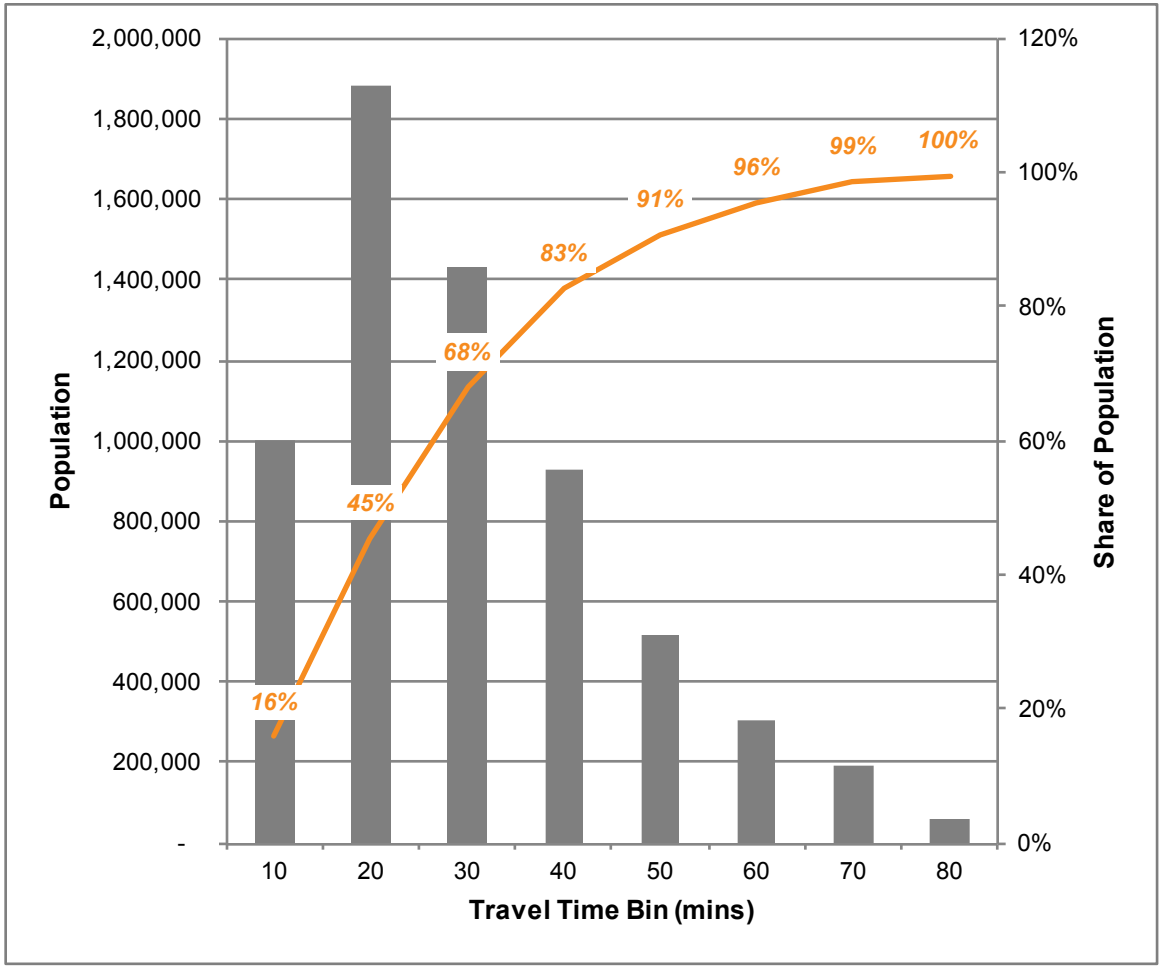
COMMUNITY COLLEGE – Accessibility Map



TN State Community Colleges

Southwest Tennessee Community College	Memphis
Jackson State Community College	Jackson
Dyersburg State Community College	Dyersburg
Columbia State Community College	Columbia
Motlow State Community College	Tullahoma
Nashville State Community College	Nashville
Volunteer State Community College	Gallatin
Chattanooga State Community College	Chattanooga
Cleveland State Community College	Cleveland
Roane State Community College	Harriman
Pellissippi State Community College	Knoxville
Walters State Community College	Morristown
Northeast State Community College	Blountville

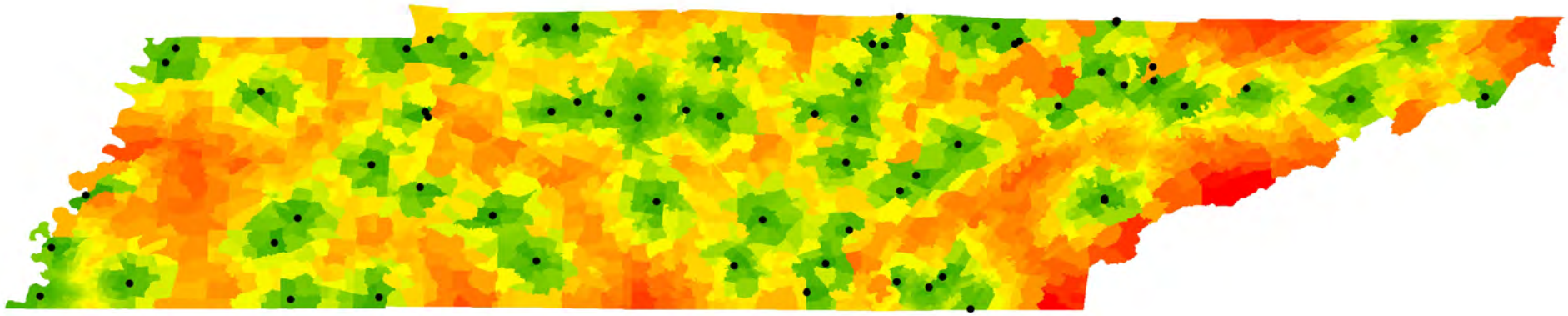
COMMUNITY COLLEGE – Population Accessibility



Time Range		Population	% Share	Cum % Share
0	10	1,002,777	16%	16%
10	20	1,881,659	30%	45%
20	30	1,433,634	23%	68%
30	40	928,569	15%	83%
40	50	518,769	8%	91%
50	60	303,901	5%	96%
60	70	192,732	3%	99%
70	80	62,941	1%	100%

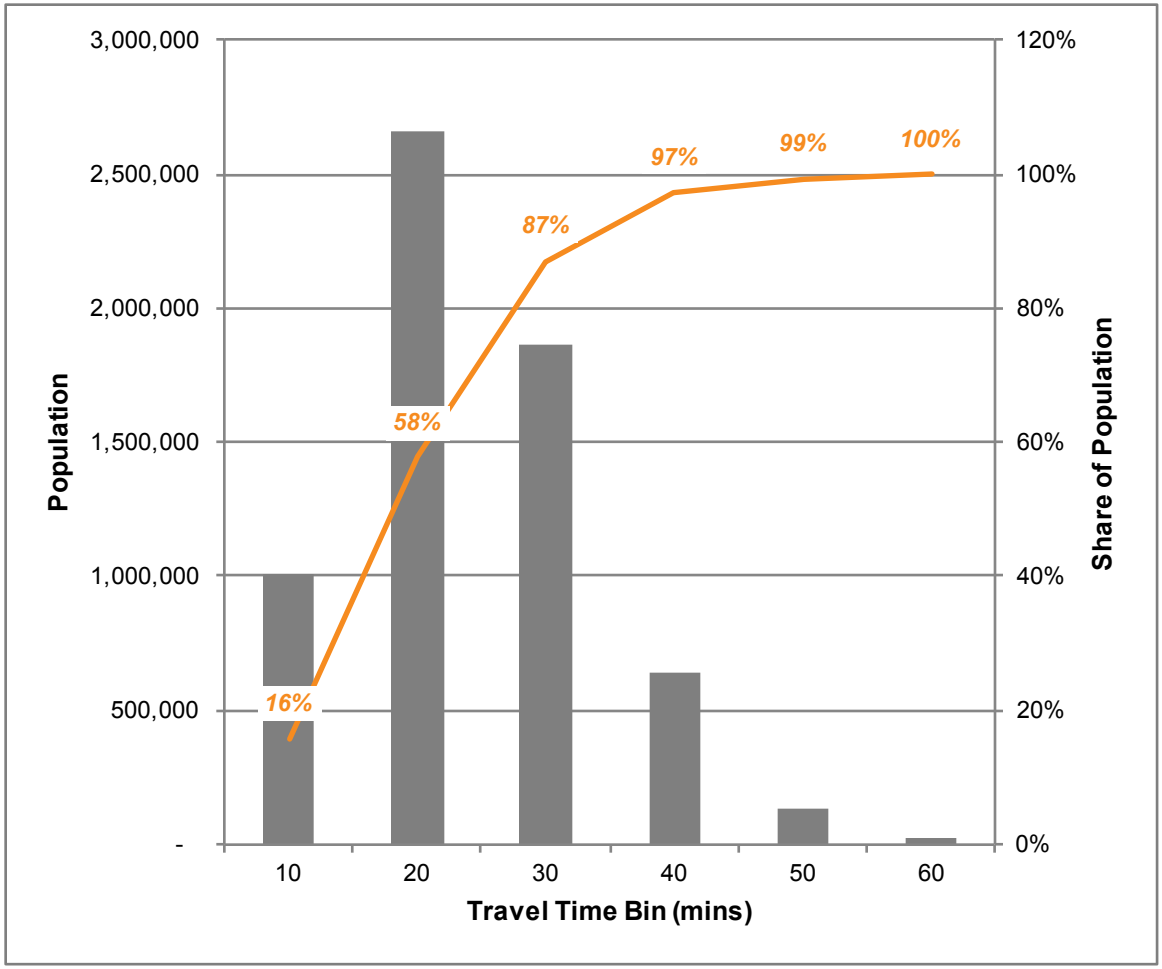
68% of the state's population is within a 30-minute drive of a community college

STATE & NAT'L PARKS – Accessibility Map



All 67 State and National Parks in Tennessee were selected

STATE & NAT'L PARKS – Population Accessibility



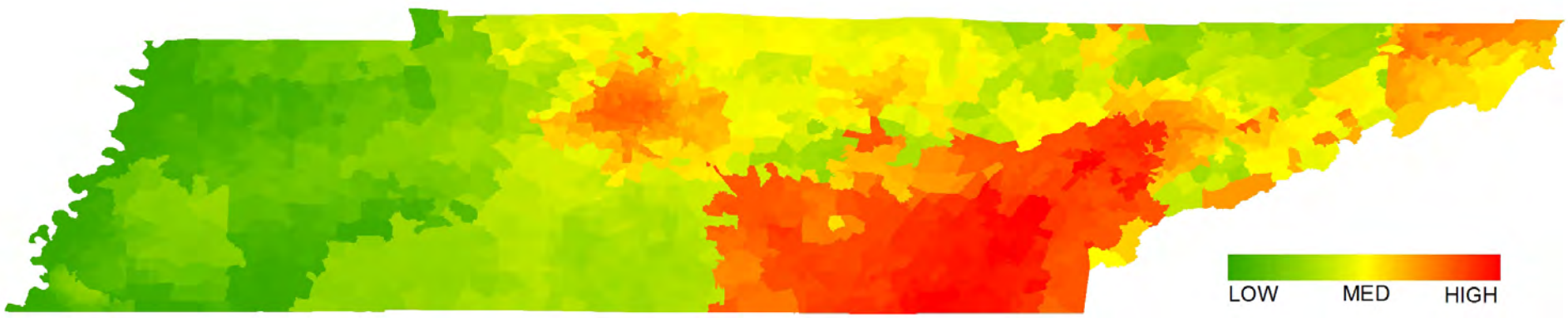
Time Range		Population	% Share	Cum % Share
0	10	1,005,474	16%	16%
10	20	2,656,061	42%	58%
20	30	1,866,740	29%	87%
30	40	646,247	10%	97%
40	50	136,125	2%	99%
50	60	28,590	0%	100%

All of the state's population is within a 1-hour drive of a state and/or national park

EMPLOYMENT & POPULATION ACCESSIBILITIES

Accessibility to Economic Markets
All Zones (Category 1-2-3-4-5)

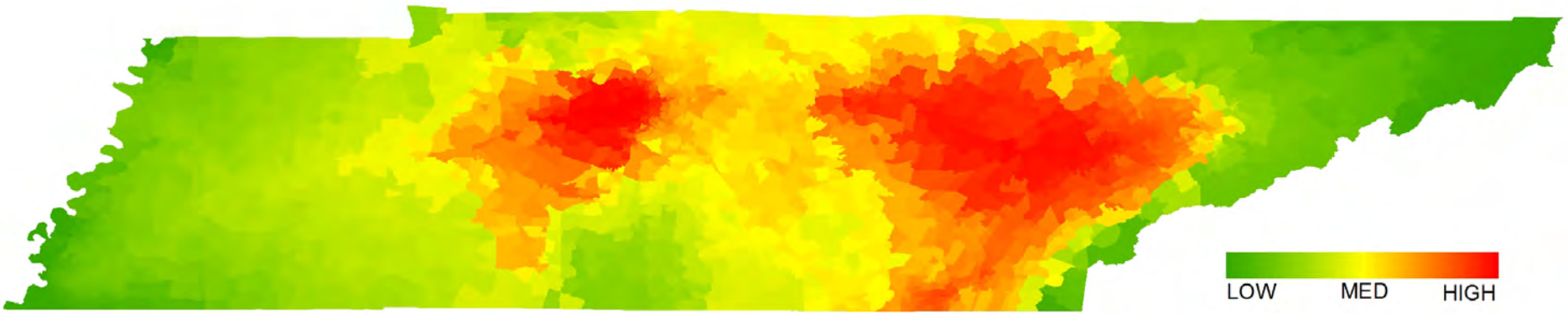
Cumulative Opportunities measure which represents the total employment (*number of jobs*) within **180-minutes** of each traffic analysis zone in the model



Note, the contribution by Category 5 zones representing **Atlanta** mega-region impacts the accessibility to economic markets for zones within Tennessee

Accessibility to Economic Markets
All Zones (Category 1-2-3-4 only)

Cumulative Opportunities measure which represents the total employment (*number of jobs*) within **180-minutes** of each traffic analysis zone in the model

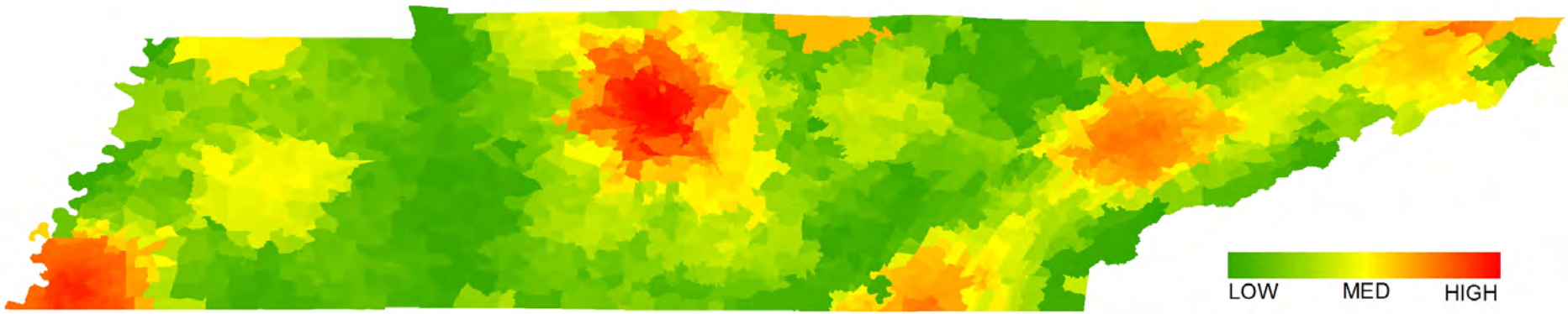


With Category 5 zones removed from consideration, the more urbanized areas within Tennessee heat up (Nashville, Knoxville, Chattanooga)

Memphis by contrast has low accessibility to markets given its distance from other major urban areas (both in TN and outside TN)

Accessibility to Employment
All Zones (Category 1-2-3-4-5)

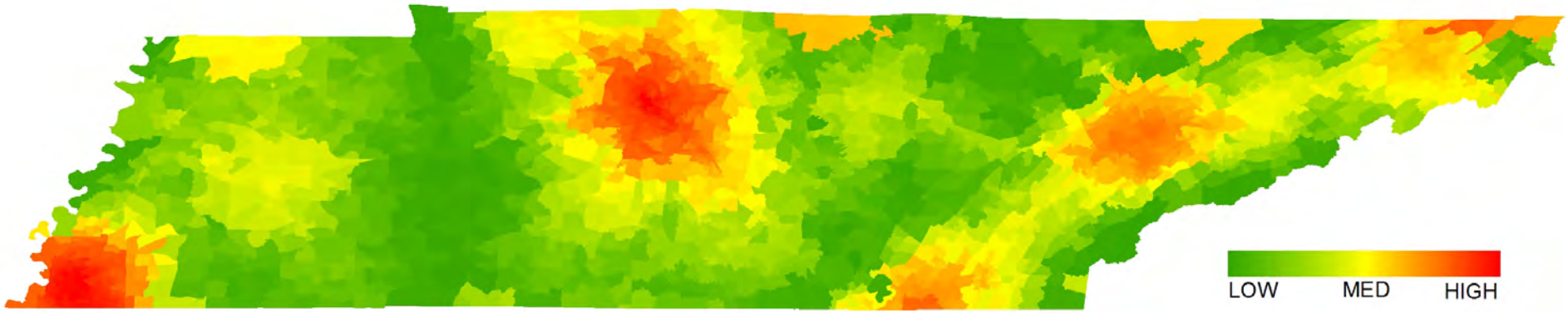
Cumulative Opportunities measure which represents the total employment (*number of jobs*) within **30-minutes** of each traffic analysis zone in the model



Zone-level *minimum* access:	460 jobs within 30-mins
Zone-level *maximum* access:	866,600 jobs within 30-mins
Zone-level *average* access:	251,500 jobs within 30-mins

Accessibility to Population (*Labor pool*) All Zones (Category 1-2-3-4-5)

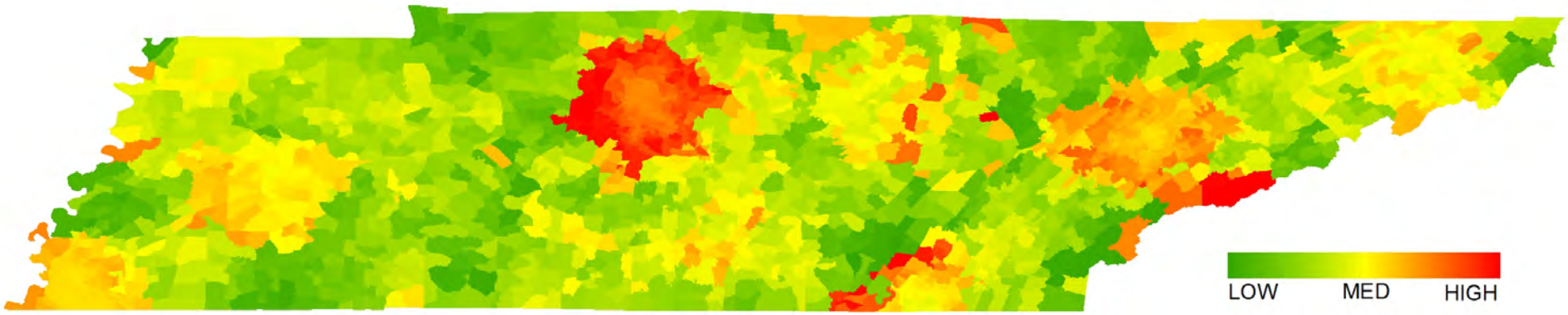
Cumulative Opportunities measure which represents the total population (*number of people*) within **30-minutes** of each traffic analysis zone in the model



Zone-level *minimum* access:	660 people within 30-mins
Zone-level *maximum* access:	1,180,700 people within 30-mins
Zone-level *average* access:	384,600 people within 30-mins

RATIO of Accessible Jobs to People
All Zones (Category 1-2-3-4-5)

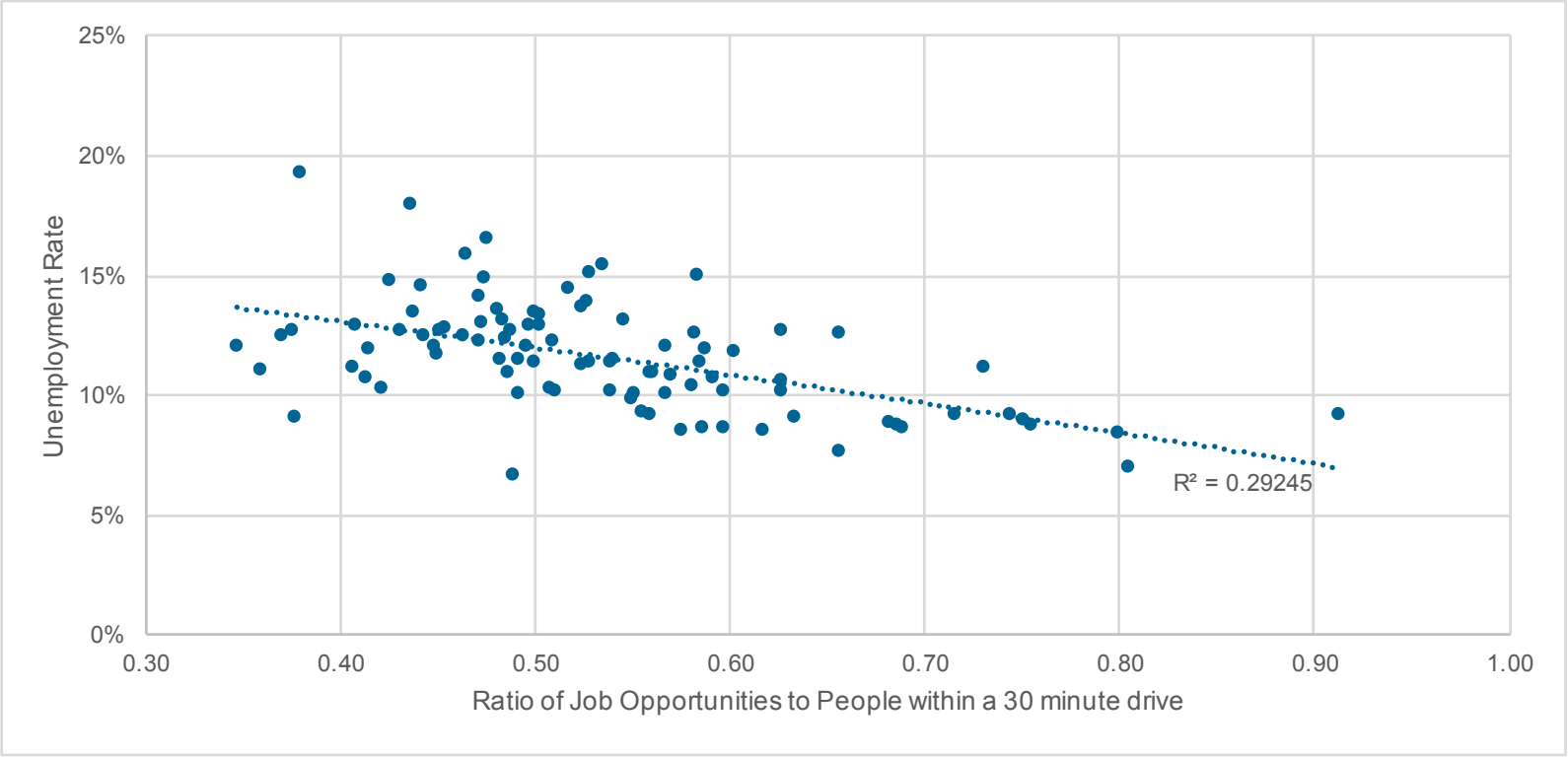
Ratio of Jobs to People is the Employment accessibility measure divided by the Population accessibility measure where both use the 30-min travel time threshold



Zone-level *minimum* ratio value:	0.12	*population >> employment*
Zone-level *maximum* ratio value:	1.26	*employment > population*
Zone-level *average* ratio value:	0.57	*employment ~ population / 2*

RATIO of Accessible Jobs to People vs County Unemployment Rates

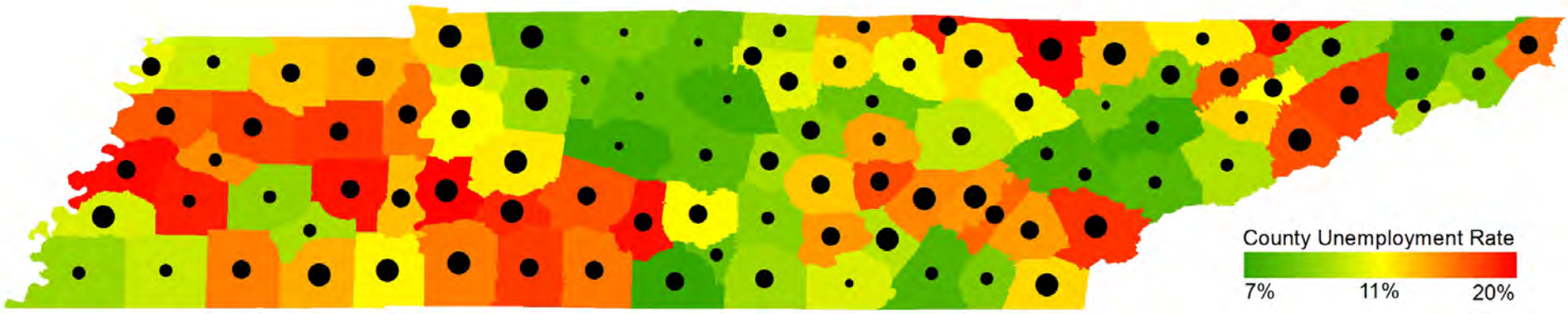
There appears to be a relationship between the **Ratio of Job Opportunities to People** within a 30-min drive and County-level unemployment in Tennessee



County-level unemployment rates: Bureau of Labor Statistics (2009-2011)

RATIO of Accessible Jobs to People vs County Unemployment Rates

Might there be a relationship between the **Ratio of Job Opportunities to People** within a 30-min drive and County-level unemployment in Tennessee?



A big dot → far more people than jobs are accessible

A small dot → approx. balance between jobs and people accessible

Displayed at county-level, a correlation between this accessibility ratio and historical unemployment rates is revealed. Most of the big dots are in orange/red counties

Ratio Measure

- 0.35 – 0.45
- 0.45 – 0.55
- 0.55 – 0.70
- 0.70 – 0.90

Phase 3: Preview!

Coming Soon!

New Data?

- Possible new data on long distance travel

Enhanced Model Features

- Time-of-Day Modeling (peak hour volumes)
- Destination Choice Models (greater accuracy)
- Full demand validation to NHTS, etc.

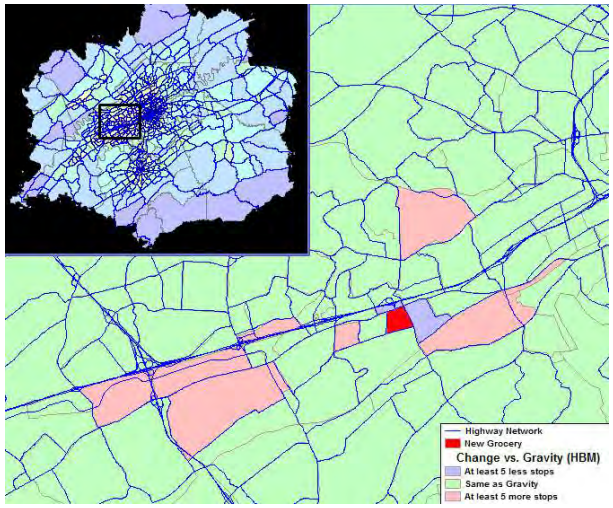
Freight!

- ATRI & Commodity flow based multi-modal freight forecasting

Destination Choice Models

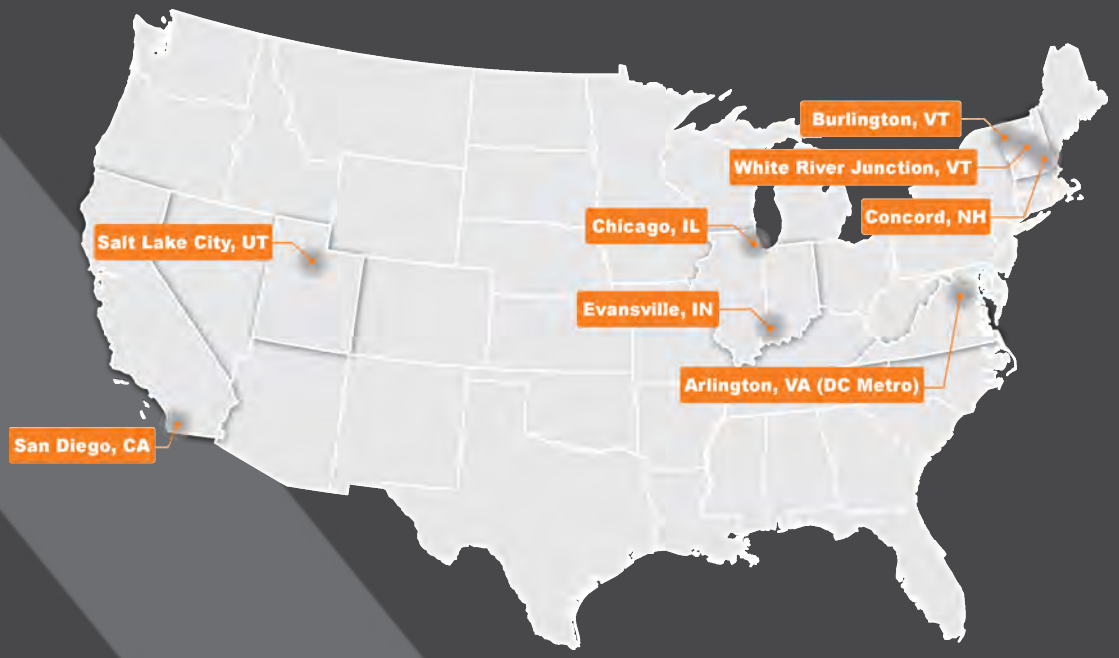
Account for More Factors

- Number of Attractions
- Travel Time / Impedance
- Effect of Residence Location on Willingness to Travel
- Psychological Boundaries
  - River Crossings
  - Ridgeline Crossings
  - Major Highway Crossings
  - State / County Line Crossings
- Walkability of Destination
- Mixture of Land Uses at Destination
- Convenience for Trip-Chaining
- Spatial Auto-correlation Effects



Trip Chaining in Knoxville

Fewer, Longer Rural Trips
More, Shorter Urban Trips



Contact

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