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

TSM Version 1
  c. 2005

Phase 1

Data (Net, TAZ, etc.)
  3/2014

Phase 2

TSM Version 2
  10/2014

Phase 3

TSM Version 3
  Fall 2015
Phase 1 of the Statewide Model Update: Data Development
## Zone Size and Network Coverage

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

*in state

- New model has **triple** the network and zones
Version 2 Network and Zones
Version 2 Network and Zones
Population Density
Employment Density

Persons per Square Mile

- 0 - 5
- 5 - 25
- 25 - 50
- 50 - 100
- 100 - 500
- 500+

2010

2040
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
  - Access Control
  - Divided Facility
  - Number of Lanes
  - Posted Speed
  - 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

<table>
<thead>
<tr>
<th></th>
<th>Raw Unsimplified Network</th>
<th>Final Simplified Network</th>
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<tr>
<td></td>
<td>Links</td>
<td>Nodes</td>
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<tr>
<td>Internal to TN</td>
<td>363,331</td>
<td>351,023</td>
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<tr>
<td>External to TN</td>
<td>28,165</td>
<td>27,374</td>
</tr>
<tr>
<td>Total</td>
<td>391,496</td>
<td>378,397</td>
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</table>

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

Facility Type

Facility Type
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.
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)

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)

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Total Trips</th>
<th>Rate per HH</th>
</tr>
</thead>
<tbody>
<tr>
<td>HBW</td>
<td>99,337,750</td>
<td>2.49</td>
</tr>
<tr>
<td>HBO</td>
<td>179,984,100</td>
<td>4.51</td>
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<tr>
<td>NHB</td>
<td>77,208,785</td>
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<tr>
<td>BUSINESS</td>
<td>341,496</td>
<td>0.01</td>
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<tr>
<td>PERSONAL</td>
<td>939,299</td>
<td>0.02</td>
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<tr>
<td>PERSONAL_BUSINESS</td>
<td>237,229</td>
<td>0.01</td>
</tr>
<tr>
<td>SU_TRUCK</td>
<td>7,170,077</td>
<td>0.18</td>
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<tr>
<td><strong>SUB-TOTAL</strong></td>
<td><strong>356,828,590</strong></td>
<td><strong>8.93</strong></td>
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</table>

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Total Trips</th>
<th>Rate per HH</th>
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</thead>
<tbody>
<tr>
<td>PASSENGER VEHICLES</td>
<td>232,551,496</td>
<td>5.82</td>
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<tr>
<td>TRUCKS (SU + ATRI)</td>
<td>8,738,329</td>
<td>0.22</td>
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<td><strong>TOTAL</strong></td>
<td><strong>241,289,825</strong></td>
<td><strong>6.04</strong></td>
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</table>

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

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Average Trip Length (miles)</th>
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</thead>
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<td>HBW</td>
<td>20.5</td>
</tr>
<tr>
<td>HBO</td>
<td>15.8</td>
</tr>
<tr>
<td>NHB</td>
<td>16.9</td>
</tr>
<tr>
<td>BUSINESS</td>
<td>178.3</td>
</tr>
<tr>
<td>PERSONAL</td>
<td>169.8</td>
</tr>
<tr>
<td>PERSONAL_BUSINESS</td>
<td>169.5</td>
</tr>
<tr>
<td>SU_TRUCK</td>
<td>20.5</td>
</tr>
<tr>
<td><strong>SUB-TOTAL</strong></td>
<td><strong>27.6</strong></td>
</tr>
</tbody>
</table>

### Type

<table>
<thead>
<tr>
<th>Type</th>
<th>Average Trip Length (miles)</th>
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</thead>
<tbody>
<tr>
<td>PASSENGER VEHICLES</td>
<td>24.3</td>
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<tr>
<td>TRUCKS (SU + ATRI)</td>
<td>49.5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>25.6</strong></td>
</tr>
</tbody>
</table>
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.)
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.

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Total Trips</th>
<th>Rate per HH</th>
<th>Average Trip Length (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HBW</td>
<td>99,337,750</td>
<td>2.49</td>
<td>20.48</td>
</tr>
<tr>
<td>LEHD_HBW</td>
<td>90,947,604</td>
<td>2.28</td>
<td>38.91</td>
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</table>

**HBW TLFDs (CAT 1-2-3 only)**

**MILES**
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

<table>
<thead>
<tr>
<th>TYPE</th>
<th>ITEM</th>
<th>NUMOBS</th>
<th>AVGCONS</th>
<th>AVGMOD</th>
<th>AVGERR</th>
<th>PCTERR</th>
<th>CORRCOEF</th>
<th>MAPE</th>
<th>PCTRMSM</th>
<th>STANDARD</th>
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<tr>
<td>Total</td>
<td>All</td>
<td>12690</td>
<td>6794.08</td>
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<td>95.09</td>
<td>1.40</td>
<td>0.96</td>
<td>51.5</td>
<td>45.6</td>
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<td>Functional Class</td>
<td>R. Interstate (1)</td>
<td>271</td>
<td>17768.52</td>
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<td>R. Prin. Arterial (2)</td>
<td>756</td>
<td>6089.74</td>
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<td>1400.37</td>
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<td>45.4</td>
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<td>954</td>
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<td>1494</td>
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<td>R. Minor Collector (8)</td>
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<td>868.12</td>
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<td>R. Local Collector (9)</td>
<td>35</td>
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<td>192.17</td>
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<td>U. Interstate (11)</td>
<td>440</td>
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<td>U. Local Road (19)</td>
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<tr>
<td>Volume Group 0</td>
<td>&lt; 5,000 AADT</td>
<td>7333</td>
<td>1672.86</td>
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<td>-4.00</td>
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<tr>
<td>Volume Group 1</td>
<td>5,000 to 10,000 AADT</td>
<td>1944</td>
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<td>Volume Group 2</td>
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<td>1702</td>
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<td>Volume Group 3</td>
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<td>Volume Group 4</td>
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<td>20166.21</td>
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<td>Volume Group 5</td>
<td>&gt; 40,000 AADT</td>
<td>660</td>
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<td>0.90</td>
<td>16.9</td>
<td>20.5</td>
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<td>Area Type</td>
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<td>-203.72</td>
<td>-10.70</td>
<td>0.75</td>
<td>69.0</td>
<td>98.0</td>
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<td>Classes</td>
<td>Local</td>
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<td>1282.09</td>
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<td>-44.98</td>
<td>0.67</td>
<td>102.3</td>
<td>102.1</td>
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</tr>
</tbody>
</table>
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

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](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
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

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

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<tr>
<th>Labels</th>
<th>Count</th>
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<tr>
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<tr>
<td>INDEPENDENT PORT</td>
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<td>RAIL</td>
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<td>16</td>
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<tr>
<td><strong>Grand Total</strong></td>
<td><strong>92</strong></td>
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MODE TYPE variable summary

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<tr>
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<td>TRUCK - PORT - RAIL</td>
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</tr>
<tr>
<td>TRUCK &amp; TRUCK</td>
<td>3</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>92</strong></td>
</tr>
</tbody>
</table>

Note, Memphis has the one PORT facility in the state on the Mississippi River.
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.
80% of the state’s goods producing employment * is within a 30-min drive of an intermodal facility

* Not service or retail employment
All 107 Park and Ride facilities in Tennessee were selected
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

<table>
<thead>
<tr>
<th>University</th>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austin Peay State University</td>
<td>Clarksville</td>
</tr>
<tr>
<td>East TN State University</td>
<td>Johnson City</td>
</tr>
<tr>
<td>Middle TN State University</td>
<td>Murfreesboro</td>
</tr>
<tr>
<td>TN State University</td>
<td>Nashville</td>
</tr>
<tr>
<td>TN Technological University</td>
<td>Cookeville</td>
</tr>
<tr>
<td>University of Memphis</td>
<td>Memphis</td>
</tr>
<tr>
<td>University of TN, Chattanooga</td>
<td>Chattanooga</td>
</tr>
<tr>
<td>University of TN, Knoxville</td>
<td>Knoxville</td>
</tr>
<tr>
<td>University of TN, Martin</td>
<td>Martin</td>
</tr>
<tr>
<td>University of TN Health Science Center</td>
<td>Memphis</td>
</tr>
<tr>
<td>University of TN Space Institute</td>
<td>Tullahoma</td>
</tr>
</tbody>
</table>
UNIVERSITIES – Population Accessibility

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

<table>
<thead>
<tr>
<th>Time Range</th>
<th>Population</th>
<th>% Share</th>
<th>Cum % Share</th>
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<tbody>
<tr>
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<td>1,214,915</td>
<td>19.3%</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>1,793,519</td>
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</tr>
<tr>
<td>20</td>
<td>30</td>
<td>1,102,966</td>
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<tr>
<td>30</td>
<td>40</td>
<td>824,172</td>
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<tr>
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<td>50</td>
<td>581,072</td>
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<tr>
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<td>60</td>
<td>440,876</td>
<td>7.0%</td>
</tr>
<tr>
<td>60</td>
<td>70</td>
<td>163,918</td>
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</tr>
<tr>
<td>70</td>
<td>80</td>
<td>90,754</td>
<td>1.4%</td>
</tr>
<tr>
<td>80</td>
<td>90</td>
<td>60,687</td>
<td>1.0%</td>
</tr>
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</table>
COMMUNITY COLLEGE – Accessibility Map

TN State Community Colleges

<table>
<thead>
<tr>
<th>College</th>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southwest Tennessee Community College</td>
<td>Memphis</td>
</tr>
<tr>
<td>Jackson State Community College</td>
<td>Jackson</td>
</tr>
<tr>
<td>Dyersburg State Community College</td>
<td>Dyersburg</td>
</tr>
<tr>
<td>Columbia State Community College</td>
<td>Columbia</td>
</tr>
<tr>
<td>Motlow State Community College</td>
<td>Tullahoma</td>
</tr>
<tr>
<td>Nashville State Community College</td>
<td>Nashville</td>
</tr>
<tr>
<td>Volunteer State Community College</td>
<td>Gallatin</td>
</tr>
<tr>
<td>Chattanooga State Community College</td>
<td>Chattanooga</td>
</tr>
<tr>
<td>Cleveland State Community College</td>
<td>Cleveland</td>
</tr>
<tr>
<td>Roane State Community College</td>
<td>Harriman</td>
</tr>
<tr>
<td>Pellissippi State Community College</td>
<td>Knoxville</td>
</tr>
<tr>
<td>Walters State Community College</td>
<td>Morristown</td>
</tr>
<tr>
<td>Northeast State Community College</td>
<td>Blountville</td>
</tr>
</tbody>
</table>
COMMUNITY COLLEGE – Population Accessibility

<table>
<thead>
<tr>
<th>Time Range</th>
<th>Population</th>
<th>% Share</th>
<th>Cum % Share</th>
</tr>
</thead>
<tbody>
<tr>
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<td>16%</td>
<td>16%</td>
</tr>
<tr>
<td>10</td>
<td>1,881,659</td>
<td>30%</td>
<td>45%</td>
</tr>
<tr>
<td>20</td>
<td>1,433,634</td>
<td>23%</td>
<td>68%</td>
</tr>
<tr>
<td>30</td>
<td>928,569</td>
<td>15%</td>
<td>83%</td>
</tr>
<tr>
<td>40</td>
<td>518,769</td>
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<td>91%</td>
</tr>
<tr>
<td>50</td>
<td>303,901</td>
<td>5%</td>
<td>96%</td>
</tr>
<tr>
<td>60</td>
<td>192,732</td>
<td>3%</td>
<td>99%</td>
</tr>
<tr>
<td>70</td>
<td>62,941</td>
<td>1%</td>
<td>100%</td>
</tr>
</tbody>
</table>

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
All of the state’s population is within a 1-hour drive of a state and/or national park.
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  \(\text{population} \gg \text{employment}\)
- Zone-level *maximum* ratio value: 1.26  \(\text{employment} > \text{population}\)
- Zone-level *average* ratio value: 0.57  \(\text{employment} \sim \text{population} / 2\)
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.

Unemployment Rate vs Ratio of Job Opportunities to People within a 30 minute drive

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.
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
Vince Bernardin, PhD, RSG
Statewide Model Update Project Manager

Vince.Bernardin@RSGinc.com
812.200.2351