Truck GPS Data for Freight Performance Measurement, Modeling, and Planning

presented to
Florida Model Task Force, Freight Committee

presented by
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Project Objectives

- Project Objectives
  - Investigate the use of ATRI-FPM data for freight performance measurement and planning in Florida.
  
  - Use the data for the following applications
    - Derive freight performance measures (speeds) for Florida’s highways
    - Algorithms for converting the GPS data into a database of truck trips
    - Understand truck travel characteristics in Florida
    - Derive truck-trip OD tables for the Florida Statewide Model

- Other
  - Assess the data – its coverage of freight truck traffic in Florida
  - Exploratory analysis of the use of data for different applications
    - Analysis of truck flows from Ports
    - Analysis of truck travel time skims
    - Analysis of truck route patterns
• Average speeds on Florida’s Strategic Intermodal System (SIS) highways
  – ATRI data used to measure average truck speeds on the entire SIS network
  – Speeds measured for different time-of-day periods for each 1-mile segment on the SIS network (half-mile segments in urban regions)
    • AM peak
    • PM peak
    • Mid day
    • Off peak
    • Daily average
  – Speeds measured based on 3 months of data in year 2010
Convert Raw GPS Data into Truck Trips

- Two types of algorithms for two types of raw data
  - Algorithm for data with spot speeds
  - Algorithm for data without spot speeds

- The algorithms were refined based on a variety of validations
  - Comparison of trip outputs with manual tracking of trucks on Google Earth
  - Checking the validity of trip end locations in Google Earth
  - Discussions with ATRI and FDOT

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Trips Extracted From 4 Weeks of GPS Data

<table>
<thead>
<tr>
<th>Duration</th>
<th># raw GPS records</th>
<th># trucks in the data</th>
<th># trips extracted that start/end in FL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 week in March 2010</td>
<td>5.39 Million</td>
<td>18,428</td>
<td>83,065</td>
</tr>
<tr>
<td>1 week in April 2010</td>
<td>4.21 Million</td>
<td>23,134</td>
<td>79,048</td>
</tr>
<tr>
<td>1 week in May 2010</td>
<td>4.88 Million</td>
<td>21,366</td>
<td>78,786</td>
</tr>
<tr>
<td>1 week in June 2010</td>
<td>5.08 Million</td>
<td>16,955</td>
<td>77,720</td>
</tr>
</tbody>
</table>
Characteristics of Truck Trips Derived from 4 Weeks of ATRI Data: Time-of-day, Trip Length, Trip Duration

Time-of-day Profile: I-E & E-I Trips for Florida

Weekdays

I-E trips: Start in Florida & end outside Florida, E-I trips: Start outside Florida & end in Florida

Time-of-day Profile of Trips Derived from 4 weeks of ATRI Data (one week in each of the following months: March, April, May, June 2010)
Time-of-day Profile: Trips within Florida (I-I Trips)

Weekdays

Time-of-day Profile of Trips Derived from 4 weeks of ATRI Data
(one week in each of the following months: March, April, May, June 2010)

Trip Duration & Length Distribution: I-E & E-I Trips

Trip Duration and Trip Length Histogram of Trips Derived from 4 weeks of
ATRI Data (one week in each of March, April, May, and June 2010)
Trip Duration & Length Distribution: Trips within FL

Weekdays

Histogram - Trip Time

Trip Total Time (in minutes)

Percentage of Truck Trips

Mean = 105.76
Std. Dev. = 108.28
N = 36,850

Histogram - Trip Length

Trip Length (in miles)

Percentage of Truck Trips

Mean = 72.21
Std. Dev. = 40.71
N = 109,920

Trip Duration and Trip Length Histogram of Trips Derived from 4 weeks of ATRI Data (one week in each of March, April, May, and June 2010)

Florida FAF Zones

Jacksonville FAF-zone
Baker, Clay, Duval, Nassau, St. Johns

Miami FAF-zone
Broward, Miami-Dade, Palm Beach

Orlando FAF-zone
Flagler, Lake, Orange, Sumter, Osceola, Seminole, Volusia

Tampa FAF-zone
Hernando, Hillsborough, Pasco, Pinellas
Time-of-day Profile: Trips within Jacksonville FAF-Zone

**Weekdays**

Frequency (Percentage)

<table>
<thead>
<tr>
<th>Time of day (0 is 12AM)</th>
<th>Trip start time</th>
<th>Trip end time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
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<td>1</td>
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<td>22</td>
</tr>
<tr>
<td>23</td>
<td>23</td>
<td>23</td>
</tr>
</tbody>
</table>

Time-of-day Profile of Trips Derived from 4 weeks of ATRI Data (one week in each of the following months: March, April, May, June 2010)

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Trip Length Distribution: Trips within Tampa FAF-Zone

**Weekdays**

Histogram - Trip Length

Trip Length Distribution of Trips Derived from 4 weeks of ATRI Data (one week in each of the following months: March, April, May, June 2010)
Trip Duration Distribution: Trips within Orlando FAF-Zone

Trip Duration Histogram of Trips Derived from 4 weeks of ATRI Data
(one week in each of the following months: March, April, May, June 2010)

Trip Speed Distribution: Trips within Miami FAF-Zone

Trip Speed Histogram of Trips Derived from 4 weeks of ATRI Data
(one week in each of the following months: March, April, May, June 2010)
### Trips Extracted From 4 Months of GPS Data

<table>
<thead>
<tr>
<th>Month</th>
<th># raw GPS records</th>
<th># trucks in the data</th>
<th># trips extracted that start/end in FL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>spot speed data</td>
<td>no-spot speed data</td>
<td>spot speed data</td>
</tr>
<tr>
<td>March 2010</td>
<td>13.3 M</td>
<td>25.7 M</td>
<td>7.5K</td>
</tr>
<tr>
<td>April 2010</td>
<td>12.9 M</td>
<td>22.8 M</td>
<td>7.6K</td>
</tr>
<tr>
<td>May 2010</td>
<td>13.3 M</td>
<td>7.5K</td>
<td></td>
</tr>
<tr>
<td>June 2010</td>
<td>13.7 M</td>
<td>7.7K</td>
<td></td>
</tr>
</tbody>
</table>

Legend:
- M = Millions
- K = Thousands

### Truck OD Patterns Extracted from 4 Months of ATRI Data with Spot Speeds (March, April, May, June 2010)
Destinations of Trips Starting in FL
(where are trips going to?)

Top 10 Destinations other than FL:
- Georgia
- Alabama
- North Carolina
- South Carolina
- Texas
- Tennessee
- Mississippi
- Louisiana
- Pennsylvania
- Michigan

Total number of trips starting in FL: 531502

Origins of Trips Ending in FL
(where are trips coming from?)

Top 10 Origins other than FL:
- Georgia
- Alabama
- South Carolina
- North Carolina
- Texas
- Tennessee
- Mississippi
- Louisiana
- Pennsylvania
- Indiana

Total number of trips ending in FL: 531149
Truck Flows to, From, and within Florida

Origins of Trips Ending in Miami-Dade county (where are trips coming from?)

Top 10 Origins other than Miami-Dade
- Broward
- Polk
- Duval
- Palm Beach
- Seminole
- Orange
- Hillsborough
- Putnam
- Monroe
- Escambia
Destinations of Trips Starting in Miami-Dade County (where are trips going to?)

Top 10 Destinations other than Miami-Dade:
- BROWARD
- DUVAL
- POLK
- PALM BEACH
- ORANGE
- HILLSBOROUGH
- OSCEOLA
- MONROE
- PUTNAM
- SARASOTA

How Much Freight Truck Traffic in Florida is Covered by the ATRI Data?

Heavy truck (class 9 - 13) counts from TTMS data vs truck counts from ATRI data
May 9-15, 2010

Heavy truck counts from TTMS data vs truck counts from ATRI data (total)
- Heavy truck counts from TTMS data
- Truck counts from ATRI data
Next Steps

• Ongoing work involves updating previous analysis with additional data (i.e., data without spot speeds)

• Next steps in the project
  - The OD patterns developed are from a sample of trips (large sample). Need to arrive at the population of truck flows
  - Perform OD matrix estimation to...
    “Inflate” the sample OD table to a population OD table...
    such that, when loaded onto the network, the resulting flows match reasonably with the observed truck traffic flows in the state
  - Travel time skims
    • Measure peak and off-peak travel times for several OD pairs for validating the FL statewide model under development

• Way forward
  - Short-term predictive analysis tool for conducting scenario analysis

Thank you

Questions and Discussion
How Much Freight-Truck Traffic in Florida is Covered by the ATRI Data?

• Aggregate percentage coverage by facility type

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>No. of count stations</th>
<th>ATRI truck counts</th>
<th>TTMS truck counts for Class 8-13</th>
<th>TTMS truck counts for Class 9-13</th>
<th>% coverage assuming ATRI data comprises trucks of class 8-13</th>
<th>% coverage assuming ATRI data comprises trucks of class 9-13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freeways &amp; Expressways (1)</td>
<td>29</td>
<td>111,608</td>
<td>1,063,765</td>
<td>869,684</td>
<td>10.5%</td>
<td>12.8%</td>
</tr>
<tr>
<td>Divided Arterials (2)</td>
<td>64</td>
<td>30,472</td>
<td>333,791</td>
<td>205,534</td>
<td>9.1%</td>
<td>14.8%</td>
</tr>
<tr>
<td>Undivided Arterials (3)</td>
<td>52</td>
<td>6,969</td>
<td>101,066</td>
<td>53,987</td>
<td>6.9%</td>
<td>12.9%</td>
</tr>
<tr>
<td>Collectors (4)</td>
<td>8</td>
<td>5,127</td>
<td>42,164</td>
<td>32,704</td>
<td>12.2%</td>
<td>15.7%</td>
</tr>
<tr>
<td>Toll Facilities (9)</td>
<td>7</td>
<td>9,291</td>
<td>80,493</td>
<td>60,012</td>
<td>11.5%</td>
<td>15.5%</td>
</tr>
<tr>
<td>Total</td>
<td>160</td>
<td>163,467</td>
<td>1,621,279</td>
<td>1,221,921</td>
<td>10.1%</td>
<td>13.4%</td>
</tr>
</tbody>
</table>

• Summary
  – ATRI data shows about 13% coverage of the truck traffic in Florida, if we assume the data comprises class 9-13 trucks
Research Task:
Characterize the movement of trucks before and after they cross the I-75 Ocala Counting Station, specifically focusing on trucks that utilize US 301.

Step One: Proof of Concept
Test using one week of data (April 26-May 2, 2010)

2,981 unique trips passed through Ocala Counting Station on I-75
Where did trucks come from that used US 301 southbound to get to I-75 southbound?

Legend
- Ocala Counting Station

Southbound Before Ocala Station - US 301 Only

Where did trucks go to that used US 301 southbound to get to I-75 southbound?

Legend
- Ocala Counting Station

Southbound After Ocala Station - US 301 Only
Destinations of Trips Starting in Hillsborough County
(where are trips going to?)

POLL
PINELLAS
ORANGE
PASCO
MANATEE
LEE
SARASOTA
OSCEOLA
DUVAL
LAKE

Origins of Trips Ending in Hillsborough county
(where are trips coming from?)

POLL
PINELLAS
ORANGE
PASCO
LEE
MANATEE
SARASOTA
OSCEOLA
DUVAL
HERNANDO
Destinations of Trips Starting in Orange County
(where are trips going to?)

Top 10 Destinations other than Orange county:
- POLK
- SEMINOLE
- LAKE
- OSCEOLA
- DUVAL
- HILLSBOROUGH
- VOLUSIA
- BREvard
- PALM BEACH
- BROWARD

Origins of Trips Ending in Orange County
(where are trips coming from?)

Top 10 Origins other than Orange county:
- POLK
- SEMINOLE
- OSCEOLA
- HILLSBOROUGH
- LAKE
- DUVAL
- ALACHUA
- VOLUSIA
- BREvard
- MIAMI-DADE
Destinations of Trips Starting in Duval County
(what are trips going to?)

Top 10 Destinations other than Duval:
- Nassau
- Orange
- Miami-Dade
- Putnam
- Polk
- Clay
- St. Johns
- Broward
- Hillsborough
- Marion

Origins of Trips Ending in Duval County
(what are trips coming from?)

Top 10 Origins other than Duval:
- Orange
- Nassau
- Miami-Dade
- Putnam
- Polk
- St. Johns
- Palm Beach
- Clay
- Broward
- Hillsborough
Destinations of Trips Starting in Polk County
(where are trips going to?)

Top 10 Destinations other than Polk
- HILLSBOROUGH
- ORANGE
- OSCEOLA
- MIAMI-DADE
- LAKE
- BROWARD
- DUVAL
- MANATEE
- PALM BEACH
- PINELLAS

Origins of Trips Ending in Polk county
(where are trips coming from?)

Top 10 Origins other than Polk
- ORANGE
- HILLSBOROUGH
- OSCEOLA
- MIAMI-DADE
- LAKE
- DUVAL
- BROWARD
- HENDRY
- PINELLAS
- PALM BEACH
Trip Length Distribution
(trips starting and/or ending in Florida)

<table>
<thead>
<tr>
<th>Trip Length (miles)</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 50</td>
<td>319171</td>
<td>54.6</td>
</tr>
<tr>
<td>50-100</td>
<td>80469</td>
<td>13.8</td>
</tr>
<tr>
<td>100-200</td>
<td>73542</td>
<td>12.6</td>
</tr>
<tr>
<td>200-500</td>
<td>74262</td>
<td>12.7</td>
</tr>
<tr>
<td>500-1000</td>
<td>23544</td>
<td>4.0</td>
</tr>
<tr>
<td>1000-2000</td>
<td>12754</td>
<td>2.2</td>
</tr>
<tr>
<td>2000-3000</td>
<td>556</td>
<td>0.1</td>
</tr>
<tr>
<td>&gt; 3000</td>
<td>206</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>584504</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Total trips 584504

Frequency Distribution Graph