Documenting Truck Activity Times at International Crossings using Available

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Panel Presentation at Nextrans Conference: Regional Strategies for Trade, Security, and Mobility Challenges at the U.S.-Canada Border

Purdue University, West Lafayette, IN
16 November 2009
Consortium for Remote Sensing of Traffic Activities

• Members
  – The Ohio State University (Columbus, OH)
  – University of Arizona (Tucson, AZ)
  – Michigan Tech Research Institute (Ann Arbor, MI)
  – Center for Automotive Research (Ann Arbor, MI)
  – Arizona State University (Tempe, AZ)
  – Skycomp, Inc. (Columbia, MD)

• Acknowledgments
  – GM Corporation – Jim Phillips
  – CEVA Logistics, Inc. – Ray Cossette, Kirk Pettit
Consortium for Remote Sensing of Traffic Activities

- Sponsorship
  - US DOT – Research and Innovative Technologies Administration: Commercial Remote Sensing and Spatial Information Technology Applications Program
  - Matching from partners

The views, opinions and statements contained in this presentation are solely those of the presenter and do not represent the official policy or position of the Department of Transportation or the Research and Innovative Technology Administration.
Geo-fence Based Approach

- Geo-fence: electronic polygon encoded into on-board data unit
- GPS-based location triggers a record when truck (OBDU) crosses the fence
- Match records for same truck trip to determine time between locations
- Encode geo-fences to delimit important activities
Geo-fence Based Approach

- Uses *existing* hardware and communications systems (OBDU)
- Roadside infrastructure not required (fewer institutional difficulties)
- Geo-fence crossing records included with many other records in overall data set
- Trip chaining required
Study Sites: Ambassador and Blue Water Bridge International Crossings

- **Ambassador Bridge**
  - Connects Detroit, MI and Windsor, ON
  - Busiest U.S. international/commercial international crossing
  - Privately owned and operated

- **Blue Water Bridge**
  - Connects Port Huron, MI and Sarnia, ON
  - Third largest U.S. international crossing
  - Publicly owned and operated
Redesigned Fences
Blue Water Bridge Crossing

Spatial Coverage
Activity Detail
Redesigned Fences
Ambassador Bridge Crossing

Spatial Coverage

Activity Detail
## Illustrative Results

### Crossing Time Statistics

<table>
<thead>
<tr>
<th></th>
<th>Original Distributions</th>
<th>Distributions w/o Duty Free Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ambassador Bridge Crossing</td>
<td>Blue Water Bridge Crossing</td>
</tr>
<tr>
<td></td>
<td>US to CAN</td>
<td>CAN to US</td>
</tr>
<tr>
<td>Number of Records</td>
<td>4215</td>
<td>5401</td>
</tr>
<tr>
<td>Median (50%-ile) Distance [km (mi)]</td>
<td>4.34 (2.70)</td>
<td>15.62 (9.70)</td>
</tr>
<tr>
<td>Median (50%-ile) Time [min]</td>
<td>11.70</td>
<td>24.60</td>
</tr>
<tr>
<td>90th Percentile (90%-ile) Time [min]</td>
<td>20.03</td>
<td>38.45</td>
</tr>
<tr>
<td>Time Variability (90%-ile - 50%-ile) [min]</td>
<td>8.33</td>
<td>13.85</td>
</tr>
</tbody>
</table>
Illustrative Results
Temporal Patterns in Crossing Times

![Map showing crossing times in different areas and line graphs showing crossing time medians at different hours of the day.](image-url)
CA to US Activity Times: Ambassador Bridge Crossing

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<thead>
<tr>
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<th>Amb usbridge</th>
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<th>Amb caplaza</th>
<th>Amb huronchrchrd</th>
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<tr>
<td>#</td>
<td>3383</td>
<td>3333</td>
<td>3395</td>
<td>3394</td>
<td>3395</td>
<td>3395</td>
<td>3392</td>
<td>3395</td>
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<tr>
<td>Median</td>
<td>0.18</td>
<td>0.22</td>
<td>4.88</td>
<td>0.82</td>
<td>1.35</td>
<td>0.95</td>
<td>4.02</td>
<td>7.95</td>
</tr>
<tr>
<td>90P</td>
<td>0.27</td>
<td>0.85</td>
<td>15.02</td>
<td>1.08</td>
<td>1.68</td>
<td>3.80</td>
<td>5.82</td>
<td>10.02</td>
</tr>
<tr>
<td>90th-Median</td>
<td>0.08</td>
<td>0.63</td>
<td>10.13</td>
<td>0.27</td>
<td>0.33</td>
<td>2.85</td>
<td>1.80</td>
<td>2.07</td>
</tr>
</tbody>
</table>
Excess Times

- Extra time (delays) resulting from congestion or flow interruptions (customs screening, toll collection, ...)
- Excess Time = Crossing Time - Free Flow Time

Example: Queuing-induced excess times over 1-mile segment upstream of customs screening

<table>
<thead>
<tr>
<th>Number of Records</th>
<th>Queuing Induced Excess Time</th>
<th>Median (50%-ile) Distance [km (mi)]</th>
<th>Median (50%-ile) Time [min]</th>
<th>90th Percentile (90%-ile) Time [min]</th>
<th>Time Variability (90%-ile - 50%-ile) [min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>US to CAN</td>
<td></td>
<td>2652</td>
<td>0.46</td>
<td>1.86</td>
<td>1.40</td>
</tr>
<tr>
<td>CAN to US</td>
<td></td>
<td>1974</td>
<td>2.13</td>
<td>12.18</td>
<td>10.05</td>
</tr>
</tbody>
</table>

Table:

- Ambassador Bridge Crossing
- Blue Water Bridge Crossing
Example: “Screening gap” excess times

<table>
<thead>
<tr>
<th></th>
<th>Screening Induced Excess Time</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Ambassador Bridge Crossing</td>
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<td></td>
<td></td>
<td>US to CAN</td>
<td>CAN to US</td>
<td>US to CAN</td>
<td>CAN to US</td>
</tr>
<tr>
<td>Number of Records</td>
<td></td>
<td>6826</td>
<td>4840</td>
<td>2613</td>
<td>1946</td>
</tr>
<tr>
<td>Median (50%-ile) Distance [km (mi)]</td>
<td>0.05 (0.03)</td>
<td>0.02 (0.01)</td>
<td>0.03 (0.02)</td>
<td>0.04 (0.02)</td>
<td></td>
</tr>
<tr>
<td>Median (50%-ile) Time [min]</td>
<td>1.10</td>
<td>1.22</td>
<td>0.93</td>
<td>1.46</td>
<td></td>
</tr>
<tr>
<td>90th Percentile (90%-ile) Time [min]</td>
<td>1.94</td>
<td>2.36</td>
<td>1.42</td>
<td>2.93</td>
<td></td>
</tr>
<tr>
<td>Time Variability (90%-ile - 50%-ile) [min]</td>
<td>0.84</td>
<td>1.14</td>
<td>0.49</td>
<td>1.47</td>
<td></td>
</tr>
</tbody>
</table>
No time-of-day pattern in “screening gap” excess times
Air-based Validation
Visualization
Advanced visualization techniques

• Goal: Ability to rapidly display PNT data and study results using advanced geospatial tools
• PostgreSQL, PostGIS, GeoServer, ArcGIS, Google Earth among software being integrated in analysis.

PNT data being fed to Google Earth from PostgreSQL database of 3,000,000+ records

Crossing time data integrated into ArcGIS from PostgreSQL for visualizing crossing times

Excess times (study results) being streamed to Google Earth and displayed dynamically via date
Benefits of Academic Setting?

• Multiple disciplines

• Academic programs often encourage academic “liberties” to pursue things not in original concept
  – Activity times
  – Visualization