Decision Support and Visualization Tools for Reliable Transportation Systems Planning

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TRB 2015 Workshop 110: Sensing Technologies for Transportation Applications
January 11, 2015
Partners & Collaborators

- Center for Transportation Policy Studies, UNC Charlotte
- Infrastructure, Design, Environment, and Sustainability (IDEAS) Center, UNC Charlotte
- North Carolina Department of Transportation (NCDOT)
- City of Charlotte Department of Transportation (CDOT)
- Charlotte Area Transit Systems (CATS)
- Charlotte Regional Transportation Planning Organization (CRTP)O
- Integrated Global Dimensions (IGD)
Research Team

• Key members associated with the development of tools
  – Kamalkannan Elangovan
  – Venkata R. Duddu

• Other key members
  – Edd Hauser
  – Md. Shah Imran
  – Pooya Najaf
  – Sai Venkata Nallamilli
  – Rahul C. Pinnamaneni
  – Ravi Kiran Puvvala
  – R. M. Zahid Reza
  – Vinay K. R. Thokala
  – Vishnu Payyavula
  – Xiaoyu Wang
Key Research / Project Tasks

- Travel time data acquisition & comparison of various technologies
  - Accuracy and sample size
- Assessment of transportation system reliability
  - Examine performance measures / spatial distribution
  - Relation between the measures
  - Recommend by purpose
- DSS tools using visualization techniques
  
http://rtsps.uncc.edu/Reliability/
Who Would Benefit from These Tools?

- **Public sector**
  - State, regional, and local agencies
    - Transportation planners and engineers
      - Which links and when are they unreliable? Cause?
    - Decision-makers
      - Where to allocate funds?

- **Private sector**
  - Transportation planners and engineers
    - Support services for state and local agencies

- **Transportation system users**
  - Commuters – departure, mode & route choice decisions
  - FedEx, UPS, … - on-time delivery
System Functionality

Server-side

Mapquest

Web server

Client-side

Web browser

User request

Results

User request
Data, Data, and More Data!

- Potential sources: INRIX, HERE, Tom Tom, …

<table>
<thead>
<tr>
<th>Year</th>
<th># TMCs</th>
<th># of Rows (Minute)</th>
<th># of Rows (Processed; Hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>296</td>
<td>155,577,600</td>
<td>78,624</td>
</tr>
<tr>
<td>2010</td>
<td>311</td>
<td>163,461,600</td>
<td>86,184</td>
</tr>
<tr>
<td>2011</td>
<td>1,972</td>
<td>1,036,483,200</td>
<td>389,256</td>
</tr>
<tr>
<td>2012</td>
<td>1,705</td>
<td>896,148,000</td>
<td>320,712</td>
</tr>
<tr>
<td>2013</td>
<td>2,049</td>
<td>1,076,954,400</td>
<td>344,232</td>
</tr>
</tbody>
</table>

2009-2012 raw data size - 130GB

2013 raw data size - 65GB
Reliability Tool: How it Works?

1. Get Year, Day, Time, Performance measure and Filter
2. Submit
3. Is valid
   - Yes
     - Get all information based on selected criteria
     - Plot each TMC on the map using lat-long coordinates and draw the route on the MapQuest map. Store all info related to the TMC on the tooltip and place it on a red marker for each TMC
   - No
     - User clicks red marker
     - Display tooltip with all the information of the selected route
     - User clicks on view visualization
     - For the selected TMC, display the visualization for the entire year
     - User clicks on download excel
     - Write all information in the map into excel format and store it in user's system
Basic Features

• Zoom in / out; pan
• Information on tooltip
• Search filters
  – Year
  – Day-of-the-week
  – Time-of-the-day
  – Reliability performance measure
• All links
Select Year
Select Day-of-the-week
Select Time-of-the-day
Select Reliability Measure
Select All Links
Decision Support & Visualizations Tools

• Performance of a selected route
• Where to allocate funds
  – Select top “N” unreliable links
• Generate reports
• When and probable cause
  – Temporal variations in reliability for a link
• Non-recurring events
  – Effect of a crash on reliability on the network
  – Effect over space and time
Select a Route
Select Top 50 Unreliable Links
Zoom to an Unreliable Link
Performance Measures of an Unreliable Link
Temporal Variations

Reliable Transportation Systems Planning Application

SELECT THE OPTIONS

2011
Select the TMC code
BTI

Buffer Time Index (BTI) = \((\frac{TT_{95} - TT_{ave}}{TT_{avg}}) \times 100\)
where, TT=Travel Time

<table>
<thead>
<tr>
<th>TMC Code</th>
<th>125P04777</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
<td>1-77 NORTHBOUND</td>
</tr>
<tr>
<td>Intersection</td>
<td>Arrowood Rd/Exit 3</td>
</tr>
<tr>
<td>Length</td>
<td>1.051439 Miles</td>
</tr>
</tbody>
</table>

The BTI: 435.8158

[Diagram showing temporal variations]
Visualization Tool: How it Works?
Temporal Variations (Cont.)

Reliable Transportation Systems Planning Application

SELECT THE OPTIONS
2011

Planning Time Index (PTI) = FF / Ffreeflow
where, FF = Travel Time

<table>
<thead>
<tr>
<th>TMC Code</th>
<th>125N11835</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
<td>Clanton Rd</td>
</tr>
<tr>
<td></td>
<td>SOUTHBOUND</td>
</tr>
<tr>
<td>Intersection</td>
<td>I-77/US-21</td>
</tr>
<tr>
<td>Length</td>
<td>0.130618 Miles</td>
</tr>
</tbody>
</table>

The PTI: 2.130345

High Risk

No Risk
| Row Num | Tmc Code | Road | Direction | Intersection | Year | Week | Time of Day | Min Travel Time | Avg Travel Time | Max Travel Time | 15th Percentile | 50th Percentile | 85th Percentile | 95th Percentile | BTI | PTI |
|---------|----------|------|-----------|--------------|------|------|-------------|----------------|---------------|---------------|----------------|----------------|----------------|----------------|----------------|-----|-----|
| 1       | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 00:00:00   | 0.671          | 0.775          | 1.966         | 0.743          | 0.778          | 0.804          | 0.804          | 0.845 | 8.925 | 1.137 |
| 2       | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 01:00:00   | 0.684          | 0.779          | 1.290         | 0.754          | 0.778          | 0.804          | 0.804          | 0.831 | 6.644 | 1.102 |
| 3       | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 02:00:00   | 0.684          | 0.778          | 0.980         | 0.766          | 0.778          | 0.804          | 0.804          | 0.831 | 6.804 | 1.085 |
| 4       | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 03:00:00   | 0.684          | 0.774          | 0.961         | 0.743          | 0.778          | 0.804          | 0.804          | 0.831 | 7.371 | 1.118 |
| 5       | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 04:00:00   | 0.684          | 0.772          | 0.908         | 0.765          | 0.778          | 0.804          | 0.804          | 0.831 | 7.633 | 1.118 |
| 6       | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 05:00:00   | 0.684          | 0.776          | 1.290         | 0.743          | 0.778          | 0.804          | 0.804          | 0.831 | 7.607 | 1.118 |
| 7       | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 06:00:00   | 0.684          | 0.761          | 2.580         | 0.71           | 0.754          | 0.804          | 0.804          | 0.831 | 9.190 | 1.170 |
| 8       | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 07:00:00   | 0.684          | 0.746          | 1.167         | 0.71           | 0.743          | 0.778          | 0.804          | 0.804 | 7.797 | 1.132 |
| 9       | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 08:00:00   | 0.684          | 0.766          | 1.442         | 0.721          | 0.754          | 0.804          | 0.804          | 0.831 | 12.266 | 1.193 |
| 10      | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 09:00:00   | 0.684          | 0.763          | 1.140         | 0.721          | 0.754          | 0.804          | 0.804          | 0.831 | 12.651 | 1.193 |
| 11      | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 10:00:00   | 0.684          | 0.750          | 1.290         | 0.721          | 0.756          | 0.804          | 0.804          | 0.831 | 7.167 | 1.133 |
| 12      | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 11:00:00   | 0.684          | 0.755          | 1.021         | 0.732          | 0.766          | 0.804          | 0.804          | 0.831 | 6.640 | 1.135 |
| 13      | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 12:00:00   | 0.684          | 0.773          | 1.325         | 0.732          | 0.766          | 0.804          | 0.804          | 0.831 | 7.528 | 1.135 |
| 14      | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 13:00:00   | 0.684          | 0.769          | 1.961         | 0.732          | 0.766          | 0.804          | 0.804          | 0.831 | 6.227 | 1.116 |
| 15      | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 14:00:00   | 0.684          | 0.771          | 1.257         | 0.732          | 0.766          | 0.804          | 0.804          | 0.831 | 7.035 | 1.135 |
| 16      | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 15:00:00   | 0.684          | 0.780          | 5.446         | 0.766          | 0.766          | 0.804          | 0.804          | 0.831 | 6.513 | 1.135 |
| 17      | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 16:00:00   | 0.684          | 0.797          | 1.021         | 0.732          | 0.766          | 0.804          | 0.804          | 0.831 | 6.326 | 1.135 |
| 18      | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 17:00:00   | 0.684          | 0.762          | 2.334         | 0.721          | 0.754          | 0.791          | 0.817          | 0.817 | 7.271 | 1.133 |
| 19      | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 18:00:00   | 0.684          | 0.764          | 1.257         | 0.721          | 0.756          | 0.804          | 0.804          | 0.817 | 6.927 | 1.133 |
| 20      | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 19:00:00   | 0.684          | 0.795          | 1.843         | 0.732          | 0.766          | 0.804          | 0.804          | 0.831 | 6.575 | 1.135 |
| 21      | 125+04630 | I-85 | NORTHBOUND | NC-27/E Exit 27 | 2010 | 2    | 20:00:00   | 0.684          | 0.778          | 1.961         | 0.743          | 0.778          | 0.804          | 0.804          | 0.831 | 6.783 | 1.118 |
Query and Generate a Report (Cont.)
Effect of Crash Tool: How it Works?
Select Severity or Type of Crash
Select Day-of-the-week
Select Time-of-the-day
Select a Route

Reliable Transportation Systems Planning Application

SELECT THE OPTIONS
- FATAL
- Monday
- 11:15

SELECT THE LOCATION
- Select Road
- Interstate 85
- Submit

For best results, we recommend using Firefox.
Select Radius
Locations of Crashes Based on Selected Options

Reliable Transportation Systems Planning Application

SELECT THE OPTIONS
- FATAL
- Monday
- Select the time

SELECT THE LOCATION
- Select Road
- Select the Radius from Crash

Displaying Crashes along INTERSTATE 85
Effect on Travel Time - Just Before Crash
Interstate (I-85)
Effect on Travel Time - Immediately After Crash
Interstate (I-85)
Effect on Travel Time - 15 Minutes After Crash
Interstate (I-85)
Effect on Travel Time - 15 Minutes After Crash
Arterial / Thoroughfare (Statesville Ave)
Summary

- Rich and detailed travel time data available for urban major roads
  - 365 days; 24 × 7; Every minute; Increasing # of links
- Enhanced ability to identify unreliable links and prioritize transportation planning projects
  - Better utilize limited transportation dollars
- Improved means and opportunity to examine the effect of incidents on network performance
  - Effectively emulate variable message signs
  - Quantify non-recurring congestion
Outreach / Dissemination

- Video clip
- Tech Brief
- Press release
- Email blast
- Technical papers & presentations
What Next?

• Integrate at system-level with other components
  – Weather data
  – Traffic counts (real-time)
  – Event planning
  – Construction activities
  – Incidents such as mechanical breakdown of vehicles
  – …
Acknowledgement

• This presentation is prepared based on information collected for a research project funded by the United States Department of Transportation – Office of the Assistant Secretary for Research and Technology (USDOT/OST-R) under Cooperative Agreement Number RITARS-12-H-UNCC.
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