Bottleneck Identification and Saxton Lab Projects

David K. Hale, Ph.D.
Leidos, Inc.

U.S. Department of Transportation
FEDERAL HIGHWAY ADMINISTRATION
Problem Statement

- Status quo methods are limited, outdated
  - Experience and judgment (not precise or scientific)
  - Peak-hour modeling (circa 1990’s)
  - Annual reliability modeling (data hungry, not cost-effective)
  - Data-driven measurements (don’t emphasize reliability)
Spatiotemporal Traffic Matrix (STM)

Source: HCM 2010
Bottleneck Intensity

• Criteria
  – Speed
  – Travel time
  – % Stops

• Bottleneck Intensity
  – Two-dimensional
  – Time and space

• Example
  – Define cutoff speeds
  – 43% of the box is red
  – Intensity = 43%
RITIS Congestion Identification

https://vpp.ritis.org/suite
RITIS Bottleneck Rankings

Impact factor = Average duration (in minutes) * average max length * number of occurrences
Google Map Feature
STM Versus ARM

- STM (Spatiotemporal Traffic State Matrix)
- ARM (Annual Reliability Matrix)
Comparing ARMs

- Bottleneck #2 is a bigger problem
- More time needed to ensure on-time arrival
Software Tool Overview

- Downloading INRIX files from RITIS
  - Readings.csv
  - TMC_Identification.csv
- https://vpp.ritis.org(suite/download/
Software Tool Overview

2. Date Range
   - Start Date: 01/01/2014
   - End Date: 12/31/2014
   - Add another date range

3. Days of week
   - Sun, Mon, Tue, Wed, Thu, Fri, Sat

4. Time of day
   - Start Time: 12:00 AM
   - End Time: 11:59 PM
   - Add another time of day

5. Fields
   - Speed
   - Historic average speed
   - Reference speed
   - Travel time
   - Confidence score
   - C-Value

6. Averaging
   - Don't average
   - 5 minutes
   - 10 minutes
   - 15 minutes
   - 30 minutes
   - 1 hour

7. Description
   - Northbound I-895

8. Notification
   - Send me an email when this export is ready

Submit download request
Play demo
Ranking Freeway Bottlenecks

- Annual intensity and reliability
  - Bottleneck Intensity Index (BII), Speed Drop (SD)

### I-695
- BII: 52%
- SD: 33%

### I-495
- BII: 46%
- SD: 17%

### I-895
- BII: 23%
- SD: 11%
Ranking Arterial Bottlenecks

- Some delay caused by signals (not congestion)
- Lower accuracy of INRIX data on arterials
- Wavelet model might help

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US-13
BII 64%

MD-147
BII 24%

US-50
BII 19%

--- Percentile worst day ---

<---Intensity--->

<---Intesity--->

<---Percentile worst day--->
Wavelet Method Example

- PM Peak (4:30 PM – 5:30 PM), 6 TMC segments
- Default cutoff speed: 25 mph
- Adjust based on 0\textsuperscript{th} percentile day
- If max speed < cutoff speed, reset cutoff speed
- This filters out “unavoidable delay”

<table>
<thead>
<tr>
<th>Time</th>
<th>Seg. 1</th>
<th>Seg. 2</th>
<th>Seg. 3</th>
<th>Seg. 4</th>
<th>Seg. 5</th>
<th>Seg. 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>4:30</td>
<td>26</td>
<td>27</td>
<td>20</td>
<td>21</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>4:45</td>
<td>28</td>
<td>25</td>
<td>24</td>
<td>19</td>
<td>22</td>
<td>25</td>
</tr>
<tr>
<td>5:00</td>
<td>30</td>
<td>23</td>
<td>22</td>
<td>19</td>
<td>24</td>
<td>23</td>
</tr>
<tr>
<td>5:15</td>
<td>28</td>
<td>25</td>
<td>22</td>
<td>17</td>
<td>22</td>
<td>27</td>
</tr>
</tbody>
</table>

0\textsuperscript{th} Percentile Day Speeds

- 25 mph
- 25 mph
- 24 mph
- 21 mph
- 24 mph
- 25 mph
Wavelet Method Example

17432 veh-hrs

85% of annual delay falls below 17432 veh-hrs

Filtering

15046 veh-hrs (13.7% reduction)

85% of annual delay falls below 15046 veh-hrs
Ranking Bottlenecks

- When comparing different INRIX datasets…
- They should have the same
  - Interval duration (e.g., 5-minute)
  - Corridor length (sum of all segments)
  - Hours of day, days of week, months of year
## Summary of Innovations

<table>
<thead>
<tr>
<th>Unaddressed Issue</th>
<th>Innovation</th>
<th>Expected Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutoff Speed</td>
<td>CBI Interface</td>
<td>weather, visibility, etc.</td>
</tr>
<tr>
<td>Variability</td>
<td>ARM</td>
<td>illustrates reliability</td>
</tr>
<tr>
<td>Numeric Index</td>
<td>BII</td>
<td>quantifies the ARM</td>
</tr>
<tr>
<td>Throughput</td>
<td>California</td>
<td>prioritizes congested roads</td>
</tr>
<tr>
<td>Signal Delay</td>
<td>Wavelet</td>
<td>reveals unavoidable delay</td>
</tr>
</tbody>
</table>
Summary

- Precise assessment of bottlenecks
- Demonstrate transportation improvements
- Justify transportation investments
- Prioritize problem areas

DAVID.K.HALE@leidos.com

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### Saxton Lab Projects

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Base Task 3</td>
<td>Vehicle Instrumentation: project complete – Taylor Lochrane GTM</td>
</tr>
<tr>
<td>Base Task 4</td>
<td>Virtual Data Access: Jocelyn Bauer - Gene McHale GTM</td>
</tr>
<tr>
<td>TO 1</td>
<td>Weather Data Environment for Connected Vehicles John Stark PI, TP is “Task Manager” - Gene McHale GTM Major Mod coming through</td>
</tr>
<tr>
<td>TO 2</td>
<td>Guidance for Alternative Intersections (HCM revisions): David Hale PI, Joe Bared GTM (almost complete)</td>
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<tr>
<td>TO 3</td>
<td>Improved Data Collection for Work Zone Gap Acceptance Field Test -</td>
</tr>
<tr>
<td>TO 4</td>
<td>Simulation of Evolutionary Introduction of Cooperative Adaptive Cruise Control: “Patrick” Su – Taylor Lochrane GTM</td>
</tr>
<tr>
<td>TO 5</td>
<td>Development of a Connected Vehicle Platform to Support CACC for a Fleet of Instrumented Research Vehicles: Frank Perry – Taylor Lochrane GTM</td>
</tr>
<tr>
<td>TO 6</td>
<td>Traffic Bottlenecks Identification and Diagnosis, Countermeasure Prioritization, and Innovative Solutions to Local/Systemic Problems: David Hale/Joe Bared GTM</td>
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<tr>
<td>TO</td>
<td>Project Description</td>
</tr>
<tr>
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<td>-------------------------------------------------------------------------------------</td>
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<tr>
<td>7</td>
<td>Revision to DSRC Roadside Equipment (RSE) Specification: Frank Perry / Deb Curtis GTM</td>
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<td>8</td>
<td>Marketing and Outreach for the Effective Integration of Analysis, Modeling, and Simulation Tools:</td>
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<td>9</td>
<td>Support to FHWA for the Creation of Desk Reference and Workshops on How to Use Archived Operations Data for Metropolitan, Statewide, and Non-Metropolitan Transportation Planning: Jocelyn Bauer</td>
</tr>
<tr>
<td>10</td>
<td>Workshop on Analysis of Network and Non-Network Impacts upon Traveler Choice:</td>
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<td>11</td>
<td>User Friendly Traffic Incident Management (TIM) Program Benefit-Cost Estimation Tool: Jiaqi Ma – Taylor Lochrane GTM</td>
</tr>
<tr>
<td>12</td>
<td>Impacts Assessment of Multi-Modal Intelligent Traffic Signal Systems: David Hale / Deb Curtis</td>
</tr>
<tr>
<td>13</td>
<td>Prototype Operational Data Environment using the Research Data Exchange: Frank Perry / Gene McHale (follow on TOPR 28)</td>
</tr>
<tr>
<td>14</td>
<td>Tools for Tactical Decision-Making/Advancing Methods for Predicting Performance: Ram Jagannathan : John Halkias</td>
</tr>
<tr>
<td>15</td>
<td>HCM Reference Guide/DTA Workshops/ATDM HCM Computational Algorithms: David Hale / Taylor Lochrane</td>
</tr>
<tr>
<td>16</td>
<td>Support for the Connected Mobile Traffic Sensing Sys &amp; Dev of Vehicle Performance Models:</td>
</tr>
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## Saxton Lab Projects

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<tr>
<th>TO 17</th>
<th>Prototype Dev &amp; Demo of Eco-Approach &amp; Departure at Single Signalized Intersection Application: John Stark/Osman Altan GTM</th>
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<td>TO 18</td>
<td>Support for Connected Vehicle Data Application: Frank Perry / Taylor Lochrane</td>
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<tr>
<td>TO 19</td>
<td>Saxton Lab Simulation Capability: Jiaqi Ma – Taylor Lochrane GTM</td>
</tr>
<tr>
<td>TO 21</td>
<td>Saxton Lab Operations Research Outreach and Communications: Ayeshah Abuelhiga/ Samantha Adam – Taylor Lochrane</td>
</tr>
<tr>
<td>TO 20</td>
<td>Lane Change/Merge Fundamental Research: Kelli Raboy/ Dan Dailey GTM</td>
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<tr>
<td>TO 22</td>
<td>Speed Harmonization Fundamental Research: Tom Phillips/Kelli Raboy Dan Dailey GTM</td>
</tr>
<tr>
<td>TO 23</td>
<td>Configuration Management for Connected Automated Research: Tom Phillips/Taylor Lochrane GTM</td>
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<tr>
<th>TO 24</th>
<th>Vehicle to Pedestrian (V2P) Test Bed Phase I: Jeff Trombly/ Karen Timpone GTM</th>
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<tbody>
<tr>
<td>TO 25</td>
<td>Development and Improvements of the Federal Roadway Testbed and Cooperative Highway Vehicle Testbed: CARY VICK/Taylor Lochrane</td>
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<tr>
<td>TO 26</td>
<td>Speed Harmonization Fundamental Research – Phase 2: Jiaqi Ma/Bob Ferlis</td>
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<td>TO 27</td>
<td>Socioeconomic Impacts Assessment for Deployment of Accessible Transportation Technologies – TBD</td>
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<td>TO 28</td>
<td>Marketing Support to Develop Communications Plans and Key Messages for Truck Platooning Research Projects: TBD</td>
</tr>
<tr>
<td>TO 29</td>
<td>Prototype Operational Data Environment – Phase 2: Frank Perry/ Gene McHale</td>
</tr>
<tr>
<td>TO 30</td>
<td>Roadside Unit (RSU) Engineering Support Services and Procurement: Frank Perry/Deb curris</td>
</tr>
<tr>
<td>TO 31</td>
<td>Saxton Transportation Lab Data Management Plan and Data Resources Test Bed Task Order: Jiaqi Ma/Jon Obenberger</td>
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