Improving Work Zone Safety and Mobility
Background

Motivation
Compliance with Final Rule on Work Zone Safety and Mobility

Funding
In 2013 MD SHA and FHWA funded a project to develop a real time performance monitoring tool for work zones using INRIX probe vehicle data and event data.
Data Sources and Key Definitions

- Active work zone information provided by SHA CHART system in real-time.
- Probe vehicle speed information from INRIX.

User Delay Cost (UDC)

Calculated using:
- ADT (AADT with adjustment factor)
- Passenger/commercial vehicle percentages
- Speed reduction factor
- Delay

Queue/Bottleneck

Roadway

Work Zone

Upstream

Work Area

Downstream
Audience and Goals

- **Audience**: Project Engineers and Managers
  - **Goals**:
    - Real time performance
    - Alerts when thresholds exceeded
    - Potential actions based on identified performance

- **Audience**: Public Relations
  - **Goals**:
    - Real time and historical performance
    - Responding to complaints and inquiries

- **Audience**: Planners and Decision Makers
  - **Goals**:
    - Closure costs
    - Review of previous performance
Work Zone Dashboard

Overview

List

Map

Critical

Delay
Work Zone Dashboard
## Critical Work Zones

<table>
<thead>
<tr>
<th>SEVERITY/EVENT</th>
<th>LANE STATUS</th>
<th>QUEUE LENGTH (M)</th>
<th>USER DELAY COST ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Critical (1)</strong></td>
<td><img src="image" alt="Lane Status" /></td>
<td>2.35</td>
<td>$7,781.00</td>
</tr>
<tr>
<td>I-695 INNER LOOP BETWEEN EXIT 12 MD 372 WILKENS AVE AND EXIT 13 MD 144 FREDERICK RD</td>
<td><img src="image" alt="Lane Status" /></td>
<td>2.35</td>
<td>$7,781.00</td>
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<tr>
<td><strong>Major (2)</strong></td>
<td><img src="image" alt="Lane Status" /></td>
<td>2.51</td>
<td>$9,527.00</td>
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<tr>
<td>RIVERDALE RD WEST BETWEEN 67TH PL AND MD 410</td>
<td><img src="image" alt="Lane Status" /></td>
<td>1.01</td>
<td>$5,507.00</td>
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<tr>
<td>I-695 OUTER LOOP WEST OF EXIT 1 MD 173 HAWKINS POINT RD (CURTIS CREEK DRAWBRIDGE)</td>
<td><img src="image" alt="Lane Status" /></td>
<td>1.5</td>
<td>$4,020.00</td>
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</tbody>
</table>
### Critical Work Zone Parameters

#### Top Critical Workzones

<table>
<thead>
<tr>
<th>Severity/Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major (80)</td>
<td></td>
</tr>
<tr>
<td>MD 216 East/West Between I-95 and US 29</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>MD 26 West at MP 16.7</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>MD 26 East at Deer Park Rd</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>MD 528 North from 56th St to 72nd St</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>I-95 North Past Exit 50 US 1 Caton Ave (Lane Shift/Long-Term)</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>I-95 North Past Exit 64[1] 695 Baltimore Beltway[MM, 64.3-64.8]</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>I-95 Outer Loop at Ardwick Ardmore Rd</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>MD 191 East at Leland St</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>I-81 South from MP 0.84 to MP 3.13</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>US 40 East/West from Washington St to I-81</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>MD 79 South/North between MD 17 and MD 180</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>I-95 South Past Exit MP 48.2 (Toll Plaza)</td>
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<tr>
<td>MD 45 North between Old Paxon Rd and Beaver Run Ln</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>MD 193 South/North at Capital Beltway</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
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<tr>
<td>US 40 East/West between I-70 and Bletzinger Rd</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>MD 136 South/North at Kerr Rd</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>I-95 North at Potomac ST on Potomac ST</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>MD 64 East from Franks Run Rd to MD 418</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>MD 68 East/West at MD 63</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
<tr>
<td>MD 97 South/North at I-70</td>
<td><img src="https://via.placeholder.com/150" alt="Graph" /></td>
</tr>
</tbody>
</table>
## User Delay Cost Information

### User Delay Cost by Corridor and Day of Week

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>I-95</td>
<td>$2,678,358.64</td>
<td>$1,239,852.54</td>
<td>$1,806,342.05</td>
<td>$3,367,462.17</td>
<td>$2,548,281.21</td>
<td>$2,661,674.89</td>
<td>$2,838,798.60</td>
<td>$2,937,018.16</td>
<td>$20,077,788.75</td>
</tr>
<tr>
<td>I-695</td>
<td>$626,606.88</td>
<td>$1,050,702.81</td>
<td>$1,105,801.53</td>
<td>$1,076,750.02</td>
<td>$905,736.49</td>
<td>$500,186.92</td>
<td>$905,736.49</td>
<td>$500,186.92</td>
<td>$4,729,538.59</td>
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<tr>
<td>US-50</td>
<td>$229,861.28</td>
<td>$301,406.33</td>
<td>$1,105,801.53</td>
<td>$107,765.02</td>
<td>$83,927.57</td>
<td>$258,710.91</td>
<td>$183,927.57</td>
<td>$183,927.57</td>
<td>$1,867,770.87</td>
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<tr>
<td>I-70</td>
<td>$48,652.15</td>
<td>$77,104.65</td>
<td>$474,634.47</td>
<td>$6,721.70</td>
<td>$212,687.02</td>
<td>$125,311.87</td>
<td>$212,687.02</td>
<td>$125,311.87</td>
<td>$640,749.82</td>
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<tr>
<td>Daily Totals</td>
<td>$3,583,478.94</td>
<td>$2,669,066.33</td>
<td>$3,493,788.29</td>
<td>$3,660,917.46</td>
<td>$2,677,692.82</td>
<td>$3,369,250.33</td>
<td>$4,128,557.87</td>
<td>$3,733,096.00</td>
<td>$27,315,684.03</td>
</tr>
</tbody>
</table>

**Footnotes:**
- **Fri Apr 11 2014:** I-695
- **Cost Per User:** $0.09
- **Delay Per User:** 0.16m
- **Total Delay:** 35070.24h
- **Total User Delay Cost:** $1,105,801.53

**Legend:**
- Weekend
- Lowest
- Highest
- No Data
### User Delay Cost by Corridor and Day of Week

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I-95</td>
<td>$2,678,358.64</td>
<td>$1,239,852.54</td>
<td>$1,806,342.05</td>
<td>$3,367,462.75</td>
<td>$2,548,281.10</td>
<td>$2,661,674.91</td>
<td>$2,838,798.60</td>
<td>$2,937,018.16</td>
<td>$20,077,788.75</td>
</tr>
</tbody>
</table>

#### Select Corridors

- Selected Corridors: I-95, I-695, US-50, I-70

- Total User Delay Cost: $27,315,848.03
- Cost Per User: $48,205.67
- Total Delay: 48,205.67
- Delay Per User: $107,767.02

### Corridor Totals

- Grand Total: $27,315,848.03

---

*Color Legend:*
- **Weekend**
- **Lowest**
- **Highest**
- **No Data**
Map Layers and Options
Individual Work Zone Profile

Map

Settings

Lanes

Performance Charts

Delay
Planned Closure @ US 29 SOUTH AT INDUSTRIAL PKWY

Data Type...
- Measured Speeds
- Comparison to Historical Average

Show...
- Work Zone Bounds
- Posted Speeds
- Associated DMS
- Nearby Cameras
- Nearby Incidents
- Lane Status
- Bottlenecks (when available)

5 miles upstream
5 miles downstream

Permit Information
Project Information
Site Details

Configure Alerts

WORK ZONE LOCATION
Lane Profile

Segment Speeds

Live CCTV & DMS

Bottlenecks & Nearby Events
### Individual Work Zone Profile

**Planned Closure @ US 29 SOUTH AT INDUSTRIAL PKWY**

**Current Conditions**

<table>
<thead>
<tr>
<th>Time</th>
<th>South</th>
<th>North</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>07:00 AM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>08:00 AM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>09:00 AM</td>
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<td></td>
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</tr>
<tr>
<td>10:00 AM</td>
<td></td>
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</tr>
<tr>
<td>11:00 AM</td>
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</tr>
<tr>
<td>12:00 PM</td>
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<tr>
<td>01:00 PM</td>
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<tr>
<td>02:00 PM</td>
<td></td>
<td></td>
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<tr>
<td>03:00 PM</td>
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</tr>
<tr>
<td>04:00 PM</td>
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<td></td>
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<tr>
<td>05:00 PM</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>06:00 PM</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**Travel Time Through Workzone Only**

**Filter Results**

- Workzone Only
- Workzone and Entire Bottleneck
- Workzone and Queue Bottleneck
- Workzone THC and S upstream

**User Delay Cost**

<table>
<thead>
<tr>
<th>Day</th>
<th>07:00 AM</th>
<th>08:00 AM</th>
<th>09:00 AM</th>
<th>10:00 AM</th>
<th>11:00 AM</th>
<th>12:00 PM</th>
<th>01:00 PM</th>
<th>02:00 PM</th>
<th>03:00 PM</th>
<th>04:00 PM</th>
<th>05:00 PM</th>
<th>06:00 PM</th>
<th>07:00 PM</th>
<th>08:00 PM</th>
<th>Total Delay Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tue 4/8/2014</td>
<td>5.78</td>
<td>5,847.29</td>
<td>12,679.06</td>
<td>3,266.29</td>
<td>2,729.48</td>
<td>727.26</td>
<td>52,207.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fri 4/11/2014</td>
<td>5.23</td>
<td>1,895.80</td>
<td>2,850.89</td>
<td>4,109.39</td>
<td>2,672.82</td>
<td>728.83</td>
<td>11,385.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sat 4/12/2014</td>
<td>5.77</td>
<td>1,666.52</td>
<td>2,128.63</td>
<td>3,283.63</td>
<td>2,832.04</td>
<td>1,488.29</td>
<td>10,124.82</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sun 4/13/2014</td>
<td>5.23</td>
<td>1,220.27</td>
<td>2,148.27</td>
<td>2,241.81</td>
<td>592.40</td>
<td>9,811.12</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mon 4/14/2014</td>
<td>5.23</td>
<td>2,454.76</td>
<td>2,821.76</td>
<td>3,140.43</td>
<td>2,940.54</td>
<td>687.16</td>
<td>9,791.94</td>
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<td></td>
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</tr>
<tr>
<td>Tue 4/15/2014</td>
<td>5.77</td>
<td>1,666.52</td>
<td>2,850.89</td>
<td>4,109.39</td>
<td>2,672.82</td>
<td>728.83</td>
<td>11,385.16</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Wed 4/16/2014</td>
<td>5.23</td>
<td>1,220.27</td>
<td>2,148.27</td>
<td>2,241.81</td>
<td>592.40</td>
<td>9,811.12</td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Hourly Totals**

- 07:00 AM: 5.78
- 08:00 AM: 5,847.29
- 09:00 AM: 12,679.06
- 10:00 AM: 3,266.29
- 11:00 AM: 2,729.48
- 12:00 PM: 727.26
- 01:00 PM: 52,207.94

**Grand Total**: 56,574.68

---

**Work Zone Performance Monitoring**

Started: Thu, Apr 17, 2014 at 09:16:31 AM
Performance Charts

SPEED THROUGH WORKZONE

Speed Through the Work Zone

Data for the week of 04/10/2014 to 04/16/2014.
Adjusting Parameters
# Individual Work Zone UDC

<table>
<thead>
<tr>
<th>Date</th>
<th>12AM - 4AM</th>
<th>4AM - 8AM</th>
<th>8AM - 12PM</th>
<th>12PM - 4PM</th>
<th>4PM - 8PM</th>
<th>8PM - 12AM</th>
<th>Daily Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thu 4/17/2014</td>
<td>$11.52</td>
<td>$183.00</td>
<td>$9,306.97</td>
<td>$16,405.23</td>
<td>$2,958.99</td>
<td>$67.58</td>
<td>$28,933.20</td>
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<tr>
<td>Fri 4/18/2014</td>
<td>$6.17</td>
<td>$29.46</td>
<td>$82.00</td>
<td>$221.35</td>
<td>$127.06</td>
<td>$50.00</td>
<td>$516.04</td>
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<td>Sat 4/19/2014</td>
<td>$27.17</td>
<td>$7.65</td>
<td>$3.12</td>
<td>$22.42</td>
<td>$17.28</td>
<td>$40.01</td>
<td>$123.69</td>
</tr>
<tr>
<td>Sun 4/20/2014</td>
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<td>$24.66</td>
<td>$0.00</td>
<td>$5.13</td>
<td>$26.78</td>
<td>$18.42</td>
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<td>Mon 4/21/2014</td>
<td>$2.46</td>
<td>$48.75</td>
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<td>Hourly Totals</td>
<td>$133.04</td>
<td>$1,035.22</td>
<td>$24,525.89</td>
<td>$39,522.78</td>
<td>$22,910.53</td>
<td>$552.59</td>
<td></td>
</tr>
</tbody>
</table>

Grand Total: $58,718.96
CREATE AN ALERT FOR THIS WORK ZONE

Fill out each section to set up an alert for this work zone.

1. Alert me if...
   - [ ] An accident happens near this work zone.
   - [ ] There is a bottleneck that's head or queue includes this work zone.
   - [ ] Speeds in the work zone fall below or exceed a certain range.

2. Alert me by...
   - [ ] Send me an email
   - [ ] Send me a text message

3. Alert me when...
   
   **Time zone**
   
   [ ] US/Eastern

   **Time period**
   
   Select days of week:
   - [Sun] Sun
   - [Mon] Mon
   - [Tue] Tue
   - [Wed] Wed
   - [Thu] Thu
   - [Fri] Fri
   - [Sat] Sat

   Select hours of day:
   - 12 AM
   - 6 AM
   - 12 PM
   - 6 PM
   - 12 AM
   
   [6:00 AM] 5:00 PM

[Create alert]
Work Zone Alerts

CREATE AN ALERT FOR THIS WORK ZONE

Fill out each section to set up an alert for this work zone.

1. Alert me if...

   - [ ] An accident happens near this work zone.
   - [ ] There is a bottleneck that’s head or queue includes this work zone. Keep in mind the formula for determining bottleneck conditions.
   - [ ] Alert me only when the queue upstream from the work zone exceeds 1.5 miles
   - [ ] Speeds in the work zone fall below or exceed a certain range.
     - [ ] When speeds fall below 35 mph
     - [ ] When speeds rise above 65 mph
   - [ ] Alert me when speed is out of range for longer than 5 minutes
   - [ ] Alert me when speed returns within range for longer than 5 minutes

2. Alert me by...

   - [ ] Send me an email
     Alert will be sent to your account email: ivanovn@umd.edu
   - [ ] Send me a text message
     Enter your phone number: 3014053626
     [ ] [ ] [ ] [ ] [ ] [ ] Verizon Wireless
     [ ] Verify

3. Alert me when...

   - [ ] US/Eastern
   - [ ] Time period
     - [ ] Run Mon Tue Wed Thu Fri Sat
     - Hours of day: 6:00 AM to 5:00 PM
   
   [ ] Select days of week

[Create alert]
Next Steps

I-95 Corridor Coalition Expansion

• I-95 CC awarded $300,000 to deploy to as many agencies as possible.
• Backend re-architecture for scalability across 17 states.
• Data collection to support the application.

Improvements

• Increased spatial granularity of probe vehicle data.
• Multiple probe vehicle data providers.
Nikola Ivanov,
http://cattlab.umd.edu
ivanovn@umd.edu