Traffic Signal Advances: Connected Vehicles, High-Resolution Data, and Performance Management

Brian Hoeft, FAST Las Vegas
Today, the automobile industry is on the cusp of a technological transformation that holds promise to catalyze an unprecedented advance in safety on U.S. roads and highways. The development of advanced automated vehicle safety technologies, including fully self-driving cars, may prove to be the greatest personal transportation revolution since the popularization of the personal automobile nearly a century ago.

For DOT, the excitement around highly automated vehicles (HAVs) starts with safety. Two numbers exemplify the need. First, 35,092 people died on U.S. roadways in 2015 alone. Second, 94 percent of crashes can be tied to a human choice or error. An important
Nevada Center for Advanced Mobility

The Nevada Center for Advanced Mobility (CAM) provides the contact point bringing together industry, government and academia to develop and deploy policy, standards and technology around advanced mobility including electric, connected, autonomous vehicles and related infrastructure.

What We Do

Mission

Nevada CAM coordinates policy development and engages public and private partners to solve worldwide mobility challenges and promote connected and autonomous vehicles globally.

Nevada CAM is charged with fostering opportunities and a progressive business and regulatory environment advantageous to the emerging sector, while ensuring safety and security are at the forefront of all innovation efforts.
IndyCar team owner, quadriplegic Sam Schmidt gets license to drive

By Brant James, USA Today 18 hours ago

Sam Schmidt prepares to drive his modified Corvette in Las Vegas on Tuesday. Schmidt was paralyzed from the neck down 16 years ago. His car uses four cameras to monitor his head and transmit his movements to the tires. He breathes in through a mouthpiece and sucks the air out when he wants to brake. (AP)

Verizon IndyCar Series team owner Sam Schmidt, who became a quadriplegic accident victim in 2000, got his driver's license to drive his modified Corvette. He won the 2004 Indy 500 in a Penske Racing car.
DOT Data Innovation Challenge attracts talented field

Posted by Victor Mendez

In February, Secretary Foxx launched DOT's Data Innovation Challenge, a three-month quest to see what app developers could do to improve transportation by taking advantage of new access to multiple sources of transportation data. Today, I'm happy to announce the results of our challenge. While we had numerous submissions, we narrowed the field down to three final winners.
Applying Archived Operations Data in Transportation Planning

A PRIMER

U.S. Department of Transportation
Federal Highway Administration

DRAFT NOT FOR DISTRIBUTION
• Visualization skills!!
• **Domain expertise.** With the right tools and the right data, anyone can review a data set and start to ask questions, but to ask the right questions, to interpret the resulting analysis, and to otherwise “act” on the information in the archive, domain expertise is needed.

• Domain experts include transportation professionals with specific technical skills in areas such as traffic operations, transportation planning, or statistical analysis.
My Agency Has Lots of Data

For agencies that are fortunate enough to have many disparate data sources at their disposal, blending and fusion concepts can and should be explored to attempt to get more out of the archived operations data sets. Creating links between data sets so that they can function together as a much larger database can make possible the use of more sophisticated analytics—searching for cause and effect, correlation of weather to safety issues, and others.

If a vast array of data is indeed available, big data techniques can allow an agency to enter the world of multi-variate data analytics, correlations, what-if scenarios, prediction, and more. Big data analytics are less about the size of the data sets than they are about a process for searching through multi-variate data sets to search for context, correlation, and other aspects that the agency may not have previously thought to ask. The goal is to extract value from the data more quickly and easily than traditional data analysis.

Numerous business and university groups specialize in big data concepts and data science. One example of applying big data analytics is the problem of determining the contribution of underlying factors to total congestion. Congestion and unreliable travel are caused by the interaction of several factors: physical capacity, demand, incidents, weather, work zones, traffic control devices, and operating policies. Assigning how much each of the factors contributes to measures like total delay is problematic, but big data analytics can help.

- Blending and fusion
- Cause & effect, correlation
- Extract value quickly and easily
- How various factors contribute
Signal Performance Metrics

Selected Signal: No Signal Selected

Signals:
- Region: All
- Metric Type: All

Filter:
- Signal Id

Map:

Metric Settings:
- Metric Type:
  - Approach Delay
  - Approach Volume
  - Arrivals On Red
  - Purdue Coordination Diagram
  - Purdue Phase Termination
  - Speed
  - Split Monitor
  - Turning Movement Counts
  - Ped Button Push Diagram

Time Y Axis Maximum: 150
Volume Y Axis Maximum: 2000
Volume Bin Size: 15
Dot Size: Small

Show Plan Statistics
Show Volumes

Export Data

Dates:
- Start Date: 9/29/2016
- End Date: 9/29/2016
- AM
- PM

Reset Date:

Create Metrics
Controller Day Plan Report

- 00:00: Planned: Patient 1 (10)
- 01:00: Planned: Patient 1 (10)
- 02:00: Planned: Patient 1 (10)
- 03:00: Planned: Patient 1 (10)
- 04:00: Planned: Patient 1 (10)
- 05:00: Planned: Patient 1 (10)
- 06:00: Planned: Patient 1 (10)
- 07:00: Planned: Patient 1 (10)
- 08:00: Planned: Patient 1 (10)
- 09:00: Planned: Patient 1 (10)
- 10:00: Planned: Patient 1 (10)
- 11:00: Planned: Patient 1 (10)
- 12:00: Planned: Patient 1 (10)
- 13:00: Planned: Patient 1 (10)
- 14:00: Planned: Patient 1 (10)
- 15:00: Planned: Patient 1 (10)
- 16:00: Planned: Patient 1 (10)
- 17:00: Planned: Patient 1 (10)
- 18:00: Planned: Patient 1 (10)
- 19:00: Planned: Patient 1 (10)
- 20:00: Planned: Patient 1 (10)
- 21:00: Planned: Patient 1 (10)
- 22:00: Planned: Patient 1 (10)
- 23:00: Planned: Patient 1 (10)

Locations:
- 3110 Selmore Ave & Decatur Blvd (TSP)
- 3404 Decatur Blvd & O'Bannon Dr (ATC)
- 3108 Decatur Blvd & O'Bannon Blvd (ATC)
- 3410 Decatur Blvd & Fairmont Place (ATC)
Figure 6.5. Observed PCDs for eight coordinated phases on SR 37 from June 6, 2009.
(a) Intersection #1 (CR 500 S).

US 231 & CR 500S

AOG: 7375/10084 (73.14%)

(b) Intersection #2 (CR 350 S).

US 231 & CR 350S (soon to be SR 26)

AOG: 7628/8730 (87.38%)

(c) Intersection #4 (River Road).

US 231 @ S River Rd

AOG: 10598/13550 (78.21%)

(d) Intersection #5 (Jischke Drive).

US 231 @ Martin Jischke Dr (Intramural Dr)

AOG: 12284/12839 (95.68%)
<table>
<thead>
<tr>
<th>Event Code</th>
<th>Event Descriptor</th>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Active Phase Events:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>Phase On</td>
<td>Phase # (1-16)</td>
<td>Set when NEMA Phase On becomes active, either upon start of green or walk interval, whichever occurs first.</td>
</tr>
<tr>
<td>1</td>
<td>Phase Begin Green</td>
<td>Phase # (1-16)</td>
<td>Set when either solid or flashing green indication has begun. Do not set repeatedly during flashing operation.</td>
</tr>
<tr>
<td>2</td>
<td>Phase Check</td>
<td>Phase # (1-16)</td>
<td>Set when a conflicting call is registered against the active phase. (Marks beginning of MAX timing)</td>
</tr>
<tr>
<td>3</td>
<td>Phase Min Complete</td>
<td>Phase # (1-16)</td>
<td>Set when phase min timer expires.</td>
</tr>
<tr>
<td>4</td>
<td>Phase Gap Out</td>
<td>Phase # (1-16)</td>
<td>Set when phase gaps out, but may not necessarily occur upon phase termination. Event may be set multiple times within a single green under simultaneous gap out.</td>
</tr>
<tr>
<td>5</td>
<td>Phase Max Out</td>
<td>Phase # (1-16)</td>
<td>Set when phase MAX timer expires, but may not necessarily occur upon phase termination due to last car passage or other cause.</td>
</tr>
</tbody>
</table>
## Signal Performance Metrics

<table>
<thead>
<tr>
<th>Label</th>
<th>Reports</th>
<th>Links</th>
<th>FAQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trip List</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Corridor:**

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Start</th>
<th>End</th>
<th>From</th>
<th>To</th>
<th>Date</th>
<th>Travel Time (s)</th>
<th>Distance (ft)</th>
<th>Avg Speed (mph)</th>
<th>Speed Limit (mph)</th>
<th>Speed Ratio</th>
<th># of Stops</th>
<th># of Signals</th>
<th>Stop%</th>
<th>Stop Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arville St</td>
<td>2232</td>
<td>2207</td>
<td>Hacienda</td>
<td>Spring Mountain Rd</td>
<td>9/13/2016 4:47:11 PM</td>
<td>423</td>
<td>11915</td>
<td>19.2</td>
<td>35</td>
<td>0.55</td>
<td>4</td>
<td>6</td>
<td>67%</td>
<td>133</td>
</tr>
<tr>
<td>Arville St</td>
<td>2232</td>
<td>2207</td>
<td>Hacienda</td>
<td>Spring Mountain Rd</td>
<td>9/20/2016 4:40:32 PM</td>
<td>557</td>
<td>11915</td>
<td>14.6</td>
<td>35</td>
<td>0.42</td>
<td>4</td>
<td>6</td>
<td>67%</td>
<td>244</td>
</tr>
<tr>
<td>Arville St</td>
<td>2444</td>
<td>2207</td>
<td>Desert Inn Rd</td>
<td>Spring Mountain Rd</td>
<td>9/21/2016 12:40:32 AM</td>
<td>66</td>
<td>1340</td>
<td>13.8</td>
<td>35</td>
<td>0.40</td>
<td>1</td>
<td>2</td>
<td>50%</td>
<td>30</td>
</tr>
<tr>
<td>Blue Diamond-Windmill</td>
<td>2009</td>
<td>2321</td>
<td>I-15 NB Ramp</td>
<td>Rainbow Blvd</td>
<td>9/14/2016 3:00:41 PM</td>
<td>383</td>
<td>20499</td>
<td>36.5</td>
<td>54</td>
<td>0.68</td>
<td>1</td>
<td>9</td>
<td>11%</td>
<td>62</td>
</tr>
<tr>
<td>Blue Diamond-Windmill</td>
<td>2012</td>
<td>2228</td>
<td>Dean Martin Dr</td>
<td>Durango Dr</td>
<td>9/4/2016 11:34:02 AM</td>
<td>464</td>
<td>28607</td>
<td>42.0</td>
<td>55</td>
<td>0.76</td>
<td>1</td>
<td>10</td>
<td>10%</td>
<td>72</td>
</tr>
<tr>
<td>Blue Diamond-Windmill</td>
<td>2228</td>
<td>2283</td>
<td>Durango Dr</td>
<td>Valley View Blvd</td>
<td>9/4/2016 9:48:56 AM</td>
<td>382</td>
<td>27882</td>
<td>49.8</td>
<td>55</td>
<td>0.90</td>
<td>0</td>
<td>9</td>
<td>0%</td>
<td>0</td>
</tr>
<tr>
<td>Bonanza Rd</td>
<td>3024</td>
<td>3023</td>
<td>Bonanza Rd</td>
<td>Las Vegas Blvd</td>
<td>9/24/2016 1:18:12 PM</td>
<td>62</td>
<td>1875</td>
<td>20.6</td>
<td>35</td>
<td>0.59</td>
<td>1</td>
<td>3</td>
<td>33%</td>
<td>6</td>
</tr>
<tr>
<td>Boulder Hwy</td>
<td>5011</td>
<td>5135</td>
<td>Water St</td>
<td>Gibson Rd</td>
<td>9/1/2016 6:22:12 PM</td>
<td>387</td>
<td>14807</td>
<td>26.1</td>
<td>45</td>
<td>0.58</td>
<td>2</td>
<td>6</td>
<td>33%</td>
<td>78</td>
</tr>
<tr>
<td>Boulder Hwy</td>
<td>5011</td>
<td>2303</td>
<td>Water St</td>
<td>Indios Ave</td>
<td>9/16/2016 3:44:55 PM</td>
<td>1149</td>
<td>37421</td>
<td>22.2</td>
<td>45</td>
<td>0.49</td>
<td>9</td>
<td>13</td>
<td>69%</td>
<td>413</td>
</tr>
<tr>
<td>Buffalo Dr Central</td>
<td>2136</td>
<td>3479</td>
<td>Spring Mountain Rd</td>
<td>Sahara Ave</td>
<td>9/13/2016 5:03:07 PM</td>
<td>135</td>
<td>6592</td>
<td>33.3</td>
<td>45</td>
<td>0.74</td>
<td>1</td>
<td>3</td>
<td>33%</td>
<td>9</td>
</tr>
<tr>
<td>Buffalo Dr Central</td>
<td>2136</td>
<td>3479</td>
<td>Spring Mountain Rd</td>
<td>Sahara Ave</td>
<td>9/20/2016 5:00:46 PM</td>
<td>134</td>
<td>6592</td>
<td>33.5</td>
<td>45</td>
<td>0.75</td>
<td>1</td>
<td>3</td>
<td>33%</td>
<td>13</td>
</tr>
<tr>
<td>Buffalo Dr Central</td>
<td>3493</td>
<td>3479</td>
<td>Summerlin Pkwy WB</td>
<td>Sahara Ave</td>
<td>9/6/2016 6:07:51 PM</td>
<td>411</td>
<td>13332</td>
<td>22.1</td>
<td>45</td>
<td>0.49</td>
<td>2</td>
<td>8</td>
<td>25%</td>
<td>139</td>
</tr>
</tbody>
</table>
Map of AVL locations recorded by Android App named "FAST AVL". Open this link in your Android browser and Download App. You may need to use "File Manager" to install this app, or "ES File Manager" App to install this app.

2:55 pm, **crash occurs**

2:58 pm, **FSP arrives**

2:59 pm

2:59 pm

3:00 pm

**40 to 50 % of crashes moved to shoulder in 10 mins or less**
Add New Incident

- **Time Stamp:** 8/9/2016 8:05 AM
- **Incident Type:**
- **Corridor:** 1-15 NB
- **Location:** Spring Mountain
- **Roadway ID:** 89
- **Segment ID:** 1
- **Which Lanes Blocked:**
- **Number of Lanes:**
- **Estimated Duration (Minutes):** 60
- **Message:**
  8/9/2016 8:05 AM,
  on I-15 Northbound at Spring Mountain,

- **Tow Truck Arrived:**
- **Lane Cleared:**
- **Severity:**
- **Quick Clearance**
- **Veh Moved By Itself**
- **Injury/Ambulance**

- **Memo:**

- **Use other routes**
- **Expect delays**
- **Shoulder Available**
- **Truck Involved**
- **Secondary**

- **Alert All**
- **GovDelivery**

**Add**

**Close**
Last example: Since Fall 2012, we have archived snapshots of the crash scene and related traffic delays. These can be used to verify secondary crashes. This slide shows the plot and the next two slides show the snapshot images.