Case Studies: Using Signal Performance Metrics to Optimize Traffic Signal Operations

March 6, 2018
Adding highway lanes to deal with traffic congestion is like loosening your belt to cure obesity.

— Lewis Mumford —
WHAT ARE SPMs?

Traffic Signal Performance Measures

- Modernize traffic signal management
- Provide high-resolution data
- Support performance-based maintenance and ops
- Improve safety and efficiency
- Cut congestion and cost
AN EVOLUTION IN SIGNAL MANAGEMENT

TRADITIONAL:
- Complaint driven
- Resource constrained
- Reactive signal operations & maintenance
- Improvement is project based, not continuous

RECOMMENDED:
- Continuous Improvement
- Measurement Driven
- Proactively planning and management
- Prove the impact of your work
- Secure funds with data driven arguments
BENEFITS OF PERFORMANCE MEASURES
WHAT GETS MEASURED GETS DONE

- High resolution data collection
- Data analysis and performance report tools
- Data-driven improvements
BENEFITS OF SIGNAL PERFORMANCE MEASURES
WHAT GETS MEASURED GETS DONE

- High resolution data collection
- Data analysis and performance report tools
- Data-driven improvements
PERCEIVED CHALLENGES

**TECHNICAL LOGISTICS**

“How do we get started?”

- Communications
- Modern controllers & detection
- Data security
- Support from IT department
- Implementation consulting

I have to solve it all to try this!

**ADOPTION**

“How do we get started?”

- Data isn’t accessible
- Expensive
- Another tool I have to learn
- What do these graphs mean?
- I don’t have time to figure this out

How do I explain this to my boss?
THE SMARTLINK STACK

- **Insights**
  - Spectrum Traffic Insights
    - Measure traffic performance
    - Prioritize resources
    - Share data

- **Inform**
  - Spectrum Signals
    - Receive traffic incident alerts
    - Gain visibility of traffic network
    - Integrate data with existing software

- **Monitor**
  - Spectrum Traffic Insights

- **Communicate**
  - Spectrum Hardware
    - Communicate data securely
    - Unlock data from infrastructure
    - Enhance detection

- **Acquire**

**Inform**

**Monitor**

**Communicate**

**Acquire**
THE FULL TRAFFIC PICTURE

1: Intersection View
Detector and signal performance data at the intersection

2: Corridor View
Aggregate intersection data and augment with travel time data

3: Network View
Aggregate corridor data with maintenance details, origin destination analysis, computer vision and summary reports
Improving Maintenance and Operations
Maintenance & Operations

CHALLENGES:

- Rural railway crossing
- 22 minute commute each direction
- 37 Rail Preempt Threshold Exceeded in one year
<table>
<thead>
<tr>
<th>Start Date</th>
<th>End Date</th>
<th>Intersection</th>
<th>Type</th>
<th>Actions</th>
<th>Status</th>
<th>Response Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wed, Aug 2, 2017</td>
<td>Wed, Aug 2, 2017</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL PRE 2)</td>
<td>Heidi Steimann and 3 others</td>
<td>Resolved</td>
<td>a minute</td>
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<td>Fri, Mar 24, 2017</td>
<td>Fri, Mar 24, 2017</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL PRE 2)</td>
<td>Call Centre and 4 others</td>
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<td>3 minutes</td>
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<td>Thu, Mar 16, 2017</td>
<td>Thu, Mar 16, 2017</td>
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<td>Jeremy Shantz and 4 others</td>
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<td>4 minutes</td>
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<td>Thu, Mar 16, 2017</td>
<td>Foundry St and Snyder's Road East</td>
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<td>Thu, Mar 16, 2017</td>
<td>Thu, Mar 16, 2017</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL PRE 2)</td>
<td>Mark Liddell and 4 others</td>
<td>Resolved</td>
<td>3 minutes</td>
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<td>Wed, Feb 15, 2017</td>
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<td>Mark Liddell and 4 others</td>
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<td>2 minutes</td>
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<td>Thu, Jan 26, 2017</td>
<td>Thu, Jan 26, 2017</td>
<td>Foundry St and Snyder's Road East</td>
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<td>Preempt Threshold Exceeded (E/W Snyder's)</td>
<td>Resolved</td>
<td>an hour</td>
</tr>
<tr>
<td>Thu, Jan 26, 2017</td>
<td>Thu, Jan 26, 2017</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL PRE 2)</td>
<td>Preempt Threshold Exceeded (E/W Snyder's)</td>
<td>Resolved</td>
<td>an hour</td>
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<td>Sat, Jan 21, 2017</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL PRE 2)</td>
<td>Call Centre and 4 others</td>
<td>Resolved</td>
<td>2 minutes</td>
</tr>
<tr>
<td>Sat, Jan 21, 2017</td>
<td>Sat, Jan 21, 2017</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL PRE 2)</td>
<td>Jeremy Shantz and 4 others</td>
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<td>Tue, Jan 3, 2017</td>
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<td>5 minutes</td>
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<td>Wed, Dec 14, 2016</td>
<td>Wed, Dec 14, 2016</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL PRE 2)</td>
<td>Mark Liddell and 4 others</td>
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<td>Fri, Dec 9, 2016</td>
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<td>Preempt Threshold Exceeded (RAIL PRE 2)</td>
<td>Heidi Steimann and 4 others</td>
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<td>Sun, Dec 4, 2016</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL PRE 2)</td>
<td>Mark Liddell and 1 other</td>
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<td>26 minutes</td>
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<td>Wed, Oct 26, 2016</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL PRE 2)</td>
<td>Mark Liddell and 1 other</td>
<td>Resolved</td>
<td>4 minutes</td>
</tr>
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<td>Wed, Sep 7, 2016</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL PRE 2)</td>
<td>Dave Fernandes and 1 other</td>
<td>Resolved</td>
<td>a minute</td>
</tr>
</tbody>
</table>
Maintenance & Operations

PRIOR TO MIOVISION:
- Complaint driven
- Time consuming communication and resolution

WITH ATSPMs:
- Minimum 75 hours saved (~2 person weeks/year)
- Resolution at the click of a button to inform rail company
- Fewer citizen complaints
- Safer road

“With Spectrum you have streaming video and real-time alerts coming back to essentially do the fieldwork from the traffic management center, and get issues cleared more quickly.”

Mark Liddell, Region of Waterloo Traffic Analyst
Improving Maintenance and Operations
WEST INA ROAD CONSTRUCTION

- Construction at West Ina Rd and I-10
- On / Off Ramp closure expected for 24 months
- Goal: measure and manage impact on Ina Rd corridor
W INA ROAD STUDY CORRIDOR

- 4 Intersections equipped with Miovision Spectrum along W Ina Rd
- Before / During / After data used to measure impact of closures and new timing plans
TRAVEL PATTERN CHANGES

- OD (Origin-Destination) changes before and after the interchange closure
- Corridor length trips decreased significantly, but N La Cañada Dr and N La Cholla still used heavily

Feb 1st, 2016

May 4th, 2016
N LA CAÑADA DR NB AND SB

- Small effect of interchange closure on the number of split failures on the NB traffic
- Significant improvement after the signal retiming
EFFECTS ON PROGRESSION

- Significant improvement in progression after retiming on the NB movement using Arrivals on Red

Before:

After:
EFFECTS ON PROGRESSION

- Significant improvement in progression after retiming on the NB movement using Purdue Coordination

Before:

After:
EFFECT ON TRAVEL TIME

- Non-optimal cycles can increase the travel time/delay
- A before and after travel time analysis reveals minimal impact of signal retiming on corridor travel time
Improving Traffic Performance
SPECTRUM CAMERA360 ENABLES DETECTION

- Detection is key to ATSPMs
- Leverage detection zones and computer vision for greater accuracy
- SmartView 360 fisheye camera provides split approach view
SPECTRUM CAMERA360
MULTI-MODAL STUDIES

- 24/7, 365 video analyzer product in cabinet
- On-demand TMC and classification studies with 95% accuracy (including ped and bike)
- Remote video monitoring and review
THE PROBLEM:
Eastbound Joy - Left Turn

- Queue failing to empty at afternoon rush hour
- Causing a backup so far back that it blocks the thru traffic
Quickly identify top offending intersections on the **Intersection Report Card**

<table>
<thead>
<tr>
<th>Intersection</th>
<th>Major Street Arrivals on Green</th>
<th>Minor Street Delay</th>
<th>Intersection Alert Count</th>
<th>Major Street Approach Volumes</th>
<th>Preempt Alerts</th>
<th>Split Failure Count</th>
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</thead>
<tbody>
<tr>
<td>Dexter and Joy</td>
<td>No data</td>
<td>0:41</td>
<td>16</td>
<td>No data</td>
<td>10</td>
<td>163</td>
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<tr>
<td>Harper and Whittier</td>
<td>72.2%</td>
<td>0:38</td>
<td>2</td>
<td>603,824</td>
<td>2</td>
<td>37</td>
</tr>
<tr>
<td>Washington and Jefferson</td>
<td>No data</td>
<td>0:56</td>
<td>11</td>
<td>No data</td>
<td>No data</td>
<td>115</td>
</tr>
<tr>
<td>Abington and Schoolcraft</td>
<td>59.2%</td>
<td>0:39</td>
<td>2</td>
<td>516,624</td>
<td>8</td>
<td>87</td>
</tr>
<tr>
<td>Artesian and Fenkell</td>
<td>51.0%</td>
<td>0:14</td>
<td>3</td>
<td>587,749 (12.1%)</td>
<td>8</td>
<td>100</td>
</tr>
<tr>
<td>Hayes and Wade</td>
<td>68.4%</td>
<td>0:52</td>
<td>11</td>
<td>No data</td>
<td>13</td>
<td>201</td>
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</table>
**OCCUPANCY RATIO**
a.k.a. Green Occupancy, Red Occupancy

Requirements: Requires stopbar presence detection

**SPLIT FAILURES**
a.k.a. Purdue Split Failure

Requirements: Requires stopbar presence detection
Split Trend Analysis - Drill down to analyze the problem
THE SOLUTION
Reallocate 3s of green time from the NB/SB movements to the EB/WB movements during the PM Peak
Verify change didn’t negatively impact other movements
Visual assessment of impact of change before and after.

BEFORE

Visually assess impact of change

AFTER
### INTERSECTIONS

**PRIMARİY DATA SET**
1 weeks to June 21, 2017 | All Days | 24 hours

**COMPARISON DATA SET**
1 weeks to May 26, 2017 | All Days | 24 hours

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<tr>
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<th>Preempt Alerts</th>
<th>Split Failure Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dexter and Joy</td>
<td>No data</td>
<td>0:47</td>
<td>11</td>
<td>22 (50.0%)</td>
<td>8</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.57 (17.3%)</td>
<td></td>
<td></td>
<td></td>
<td>163 (41.7%)</td>
</tr>
<tr>
<td>Harper and Whittier</td>
<td>72.2%</td>
<td>0:14</td>
<td>3</td>
<td>516,624</td>
<td>2</td>
<td>118</td>
</tr>
<tr>
<td></td>
<td>71.7% (0.7%)</td>
<td>0.16 (12.5%)</td>
<td></td>
<td>587,749 (12.1%)</td>
<td></td>
<td>153 (29.6%)</td>
</tr>
<tr>
<td>Washington and Jefferson</td>
<td>No data</td>
<td>0:56</td>
<td>11</td>
<td>No data</td>
<td>No data</td>
<td>750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.58 (3.4%)</td>
<td></td>
<td></td>
<td></td>
<td>972 (22.8%)</td>
</tr>
<tr>
<td>Abington and Schoolcraft</td>
<td>59.2%</td>
<td>0:39</td>
<td>2</td>
<td>603,824</td>
<td>10</td>
<td>253</td>
</tr>
<tr>
<td></td>
<td>59.4% (1.4%)</td>
<td>0.39 (2.6%)</td>
<td></td>
<td>608,483 (0.8%)</td>
<td></td>
<td>282 (10.3%)</td>
</tr>
<tr>
<td>Artesian and Fenkell</td>
<td>51.0%</td>
<td>0:38</td>
<td>2</td>
<td>No data</td>
<td>No data</td>
<td>421</td>
</tr>
<tr>
<td></td>
<td>49.7% (2.6%)</td>
<td>0.38 (-%)</td>
<td></td>
<td></td>
<td></td>
<td>459 (8.3%)</td>
</tr>
<tr>
<td>Hayes and Wade</td>
<td>68.4%</td>
<td>0:52</td>
<td>16</td>
<td>No data</td>
<td>13</td>
<td>326</td>
</tr>
<tr>
<td></td>
<td>67.9% (0.1%)</td>
<td>0.57 (8.7%)</td>
<td></td>
<td></td>
<td></td>
<td>331 (0.2%)</td>
</tr>
</tbody>
</table>

The result... **41.7% reduction in Split Failures** at Intersection
MIOVISION ATSPM ADOPTION MODEL

**Problem Discovery**
- Work to understand your challenges

**Integration Planning**
- Translate challenges into requirements

**Procurement Support**
- Provide expertise on securing funding

**Implementation**
- Ensure deployment is timely & success

**Continuous Improvement**
- Continue to understand and innovate based on your evolving needs

### What We Provide

<table>
<thead>
<tr>
<th>MIOVISION RESOURCES</th>
<th>WHAT WE PROVIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem discovery</td>
<td>Provide technical details about existing infrastructure</td>
</tr>
<tr>
<td>Stakeholder involvement</td>
<td>Support grants applications or vying for internal funding</td>
</tr>
<tr>
<td>Technical planning document Business case development</td>
<td>Access to relevant staff for installation and training</td>
</tr>
<tr>
<td>Grant application writing Technical specifications</td>
<td>Feedback about how Miovision products can better meet your needs</td>
</tr>
<tr>
<td>Project management Detailed installation instructions</td>
<td>Product discovery managers</td>
</tr>
<tr>
<td>Product roadmaps</td>
<td></td>
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</tbody>
</table>
Thank you

Erin Skimson
eskimson@miovision.com