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

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

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

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

Insights
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
CHALLENGES:

- Rural railway crossing
- 22 minute commute each direction
- 37 Rail Preempt Threshold Exceeded in one year
<table>
<thead>
<tr>
<th>Start</th>
<th>End</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 5:59 PM</td>
<td>Wed, Aug 2, 2017 6:00 PM</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL (PRE 2))</td>
<td>Heidi Steinman and 3 others</td>
<td>Resolved</td>
<td>a minute</td>
</tr>
<tr>
<td>Fri, Mar 24, 2017 4:43 PM</td>
<td>Fri, Mar 24, 2017 4:43 PM</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>3 minutes</td>
</tr>
<tr>
<td>Thu, Mar 16, 2017 11:12 PM</td>
<td>Thu, Mar 16, 2017 11:15 PM</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>
<td>Resolved</td>
<td>4 minutes</td>
</tr>
<tr>
<td>Thu, Mar 16, 2017 10:44 PM</td>
<td>Thu, Mar 16, 2017 11:03 PM</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL (PRE 1))</td>
<td>Dave Fernandes and 4 others</td>
<td>Resolved</td>
<td>19 minutes</td>
</tr>
<tr>
<td>Thu, Mar 16, 2017 10:33 PM</td>
<td>Thu, Mar 16, 2017 10:35 PM</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL (PRE 1))</td>
<td>Heidi Steinman and 4 others</td>
<td>Resolved</td>
<td>3 minutes</td>
</tr>
<tr>
<td>Thu, Mar 16, 2017 10:33 PM</td>
<td>Thu, Mar 16, 2017 10:35 PM</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL (PRE 1))</td>
<td>Mark Liddell and 4 others</td>
<td>Resolved</td>
<td>a few seconds</td>
</tr>
<tr>
<td>Wed, Feb 15, 2017 6:45 PM</td>
<td>Wed, Feb 15, 2017 6:46 PM</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>2 minutes</td>
</tr>
<tr>
<td>Thu, Jan 26, 2017 7:33 AM</td>
<td>Thu, Jan 26, 2017 7:32 AM</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>an hour</td>
</tr>
<tr>
<td>Thu, Jan 26, 2017 7:33 AM</td>
<td>Thu, Jan 26, 2017 7:32 AM</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>2 minutes</td>
</tr>
<tr>
<td>Wed, Dec 14, 2016 8:00 AM</td>
<td>Wed, Dec 14, 2016 11:04 AM</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL (PRE 2))</td>
<td>Dave Fernandes and 4 others</td>
<td>Resolved</td>
<td>3 hours</td>
</tr>
<tr>
<td>Fri, Dec 9, 2016 10:47 AM</td>
<td>Fri, Dec 9, 2016 10:48 AM</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL (PRE 1))</td>
<td>Jeremy Shantz and 4 others</td>
<td>Resolved</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Sun, Dec 4, 2016 4:15 PM</td>
<td>Sun, Dec 4, 2016 4:52 PM</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL (PRE 2))</td>
<td>Heidi Steinman and 4 others</td>
<td>Resolved</td>
<td>37 minutes</td>
</tr>
<tr>
<td>Sun, Dec 4, 2016 3:31 PM</td>
<td>Sun, Dec 4, 2016 4:48 PM</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>
<td>Resolved</td>
<td>an hour</td>
</tr>
<tr>
<td>Sun, Dec 4, 2016 3:50 PM</td>
<td>Sun, Dec 4, 2016 4:52 PM</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL (PRE 1))</td>
<td>Call Centre and 4 others</td>
<td>Resolved</td>
<td>2 minutes</td>
</tr>
<tr>
<td>Sat, Dec 3, 2016 1:50 PM</td>
<td>Sat, Dec 3, 2016 1:53 PM</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL (PRE 1))</td>
<td>Jeremy Shantz and 4 others</td>
<td>Resolved</td>
<td>2 minutes</td>
</tr>
<tr>
<td>Sat, Dec 3, 2016 1:39 PM</td>
<td>Sat, Dec 3, 2016 1:44 PM</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL (PRE 1))</td>
<td>Dave Fernandes and 4 others</td>
<td>Resolved</td>
<td>5 minutes</td>
</tr>
<tr>
<td>Sat, Dec 3, 2016 6:23 PM</td>
<td>Sat, Dec 3, 2016 6:23 PM</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL (PRE 1))</td>
<td>Mark Liddell and 4 others</td>
<td>Resolved</td>
<td>a minute</td>
</tr>
<tr>
<td>Sat, Dec 3, 2016 6:22 PM</td>
<td>Sat, Dec 3, 2016 6:23 PM</td>
<td>Foundry St and Snyder's Road East</td>
<td>Preempt Threshold Exceeded (RAIL (PRE 1))</td>
<td>Mark Liddell and 4 others</td>
<td>Resolved</td>
<td>a few seconds</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
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
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
<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>
</tr>
</thead>
<tbody>
<tr>
<td>Dexter and Joy</td>
<td>No data</td>
<td>0:32 (31.3%) ↑</td>
<td>16</td>
<td>No data</td>
<td>10</td>
<td>163 (39.3%) ↑</td>
</tr>
<tr>
<td>Harper and Whittier</td>
<td>72.2% (0.7%) ↓</td>
<td>0:38</td>
<td>2</td>
<td>603,824</td>
<td>2</td>
<td>37 (25.5%) ↑</td>
</tr>
<tr>
<td>Washington and Jefferson</td>
<td>No data</td>
<td>0:56 (3.4%) ↓</td>
<td>11</td>
<td>No data</td>
<td>No data</td>
<td>115 (6.5%) ↑</td>
</tr>
<tr>
<td>Abington and Schoolcraft</td>
<td>59.2% (1.4%) ↓</td>
<td>0:39 (2.5%) ↑</td>
<td>2</td>
<td>516,624</td>
<td>8</td>
<td>87 (6.1%) ↑</td>
</tr>
<tr>
<td>Artesian and Fenkell</td>
<td>51.0% (2.6%) ↓</td>
<td>0:16 (12.5%) ↓</td>
<td>3</td>
<td>No data</td>
<td>No data</td>
<td>100 (2.0%) ↑</td>
</tr>
<tr>
<td>Hayes and Wade</td>
<td>68.4% (0.1%) ↓</td>
<td>0:52 (8.7%) ↓</td>
<td>11</td>
<td>No data</td>
<td>13</td>
<td>201 (0.5%) ↑</td>
</tr>
</tbody>
</table>

Quickly identify top offending intersections on the Intersection Report Card
**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 - Drilldown 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
Visually assess impact of change
The result... **41.7% reduction in Split Failures** at Intersection

<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>
</tr>
</thead>
<tbody>
<tr>
<td>Dexter and Joy</td>
<td>0:47</td>
<td>0.57 (17.3%)</td>
<td>11</td>
<td>22</td>
<td>8</td>
<td>95</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>Washington and Jefferson</td>
<td>No data</td>
<td>0.56</td>
<td>11</td>
<td>587,749 (12.1%)</td>
<td>5</td>
<td>750</td>
</tr>
<tr>
<td>Abington and Schoolcraft</td>
<td>0.39</td>
<td>0.38 (2.5%)</td>
<td>2</td>
<td>603,824</td>
<td>10</td>
<td>253</td>
</tr>
<tr>
<td>Artesian and Fenkell</td>
<td>0.38 (100.0%)</td>
<td>No data</td>
<td>2</td>
<td>608,483 (0.8%)</td>
<td>No data</td>
<td>421</td>
</tr>
<tr>
<td>Hayes and Wade</td>
<td>0.52</td>
<td>0.57 (8.7%)</td>
<td>16</td>
<td>No data</td>
<td>13</td>
<td>326</td>
</tr>
</tbody>
</table>
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**

- Problem discovery
  - Stakeholder involvement
- Technical planning document
- Business case development
- Grant application writing
- Technical specifications
- Project management
- Detailed installation instructions
- Product discovery managers
- Product roadmaps

---

**WHAT WE ASK OF YOU**

- Engagement from relevant stakeholders
- Provide technical details about existing infrastructure
- Support grants applications or vying for internal funding
- Access to relevant staff for installation and training
- Feedback about how Miovision products can better meet your needs
Thank you

Erin Skimson
eskimson@miovision.com