EDC4 Automated Traffic Signal Performance Measures
What is it?

A suite of performance measures, event based data collection, and data analysis tools to support a performance based approach to managing a traffic signal program.
State of the Practice

Program Management
- Ad-hoc Business Practices
- Resource Constrained
- Outdated Equipment

Performance Assessment
- Complaint Driven
- Reactive Operations & Maintenance
- Project Oriented Before & After

Source: FHWA
Automated Traffic Signal Performance Measures

Three components

1. **Suite of Performance Measures** that support Objectives & Performance Based Approaches to Traffic Signals for Maintenance and Operations

2. Data Collection

3. Data Analysis
Suite of Measures (Sample)

Operations
- Yellow and Red Actuations
- Arrivals on Red
- Ped/Bike Delay
- Purdue Coordination Diagram
- Split Failure
- Queue length
- Split Monitoring
- Travel Time
- Turning Movement Counts

Maintenance
- False Calls
- Preemption Details
- Communication Failures
- Alarms
ATSMP = Fitness Tracker for Traffic Signals

Data Analysis and Performance Report Tools

High Resolution Data Collection

+ Other solutions....

Source: FHWA
PERFORMANCE MEASURES FOR TRAFFIC SIGNAL SYSTEMS

An Outcome-Oriented Approach

Implementation of Automated Traffic Signal Performance Measures


Over the last few decades traffic signal systems have evolved from rigid, fixed-time electromechanical systems to a distributed computing model with sophisticated detection and communication infrastructure. Although modern signal systems are relatively robust, operating continuously for years under all weather conditions, there is a tendency for operational inefficiencies to accumulate over time, as individual components such as detectors fail, or traffic conditions evolve beyond the parameters that the signal control was designed to accommodate. For a number of years, the engineering community has acknowledged opportunities for improvement, such as retaining or investing in new equipment. However, historically, it has been very difficult to comprehensively evaluate changes in signal operations because the cost of data collection constrained the temporal and spatial extent of study.
**ATSPM Basic Concept**

Hi Def Data Logger included in controller firmware

Hi Def logs retrieved every 10-60 minutes from controller to server

Website to display SPM’s

(Or…Retrieve data logs from controller manually using Raspberry Pi)
<table>
<thead>
<tr>
<th>Detection</th>
<th>Metric</th>
</tr>
</thead>
</table>
| None      | Purdue Phase Termination  
|           | Split Monitor  
|           | Preemption Details  
|           | Pedestrian Delay |
| Advanced Count | Purdue Coordination Diagram  
|               | Approach Volume  
|               | Approach Speed (requires detection with speed service) |
| Lane-by-lane Presence Lane Group Presence | Purdue Split Failure |
| Lane-by-lane Stopbar Count | Turning Movement Counts |
Detection

None

Available Metrics

- Purdue Phase Termination
- Split Monitor
- Pedestrian Delay
- Preemption Details
Metric: Purdue Phase Termination

- Gap out
- Max out
- Force off
- Pedestrian activation
  (shown above phase line)
- Skip

Purdue Phase Termination

Metric: Purdue Phase Termination

- Free
- Coordinated phases
- Time of Day
- Phase Number
- Pedestrian activation
  (shown above phase line)
- Skip
- Force off
Nighttime detection problem

BEFORE: Detection not working at night

Minor street through & left turn max out at night only
Nighttime detection problem - Fixed!

AFTER: New detection technology installed

Phases are rarely used at night
Pedestrian Delay
(Time from pedestrian call received to start of the walk indication)

Phase 4 – Side Street – Friday September 16th 2016

89 Ped Actuations → 48 s = Average Delay
Detection

Setback Count Zones

Available Metrics

- Purdue Coordination Diagram
- Approach Volume
- Arrivals on Red
- Approach Delay
Purdue Coordination Diagram

VIDEO

https://www.youtube.com/watch?v=YhrtTuhcjMw
Purdue Coordination Diagram
Purdue Coordination Diagram

Left turns from upstream signal
Monitoring Trends
(Riverdale Rd – 11 intersections)

Percent of Vehicles Arriving on Green - Riverdale Rd
10:00 AM to 2:00 PM Monday through Friday

Retiming Project
System Health Alerts

SPM Alerts for 5/22/2016

--The following signals had too few records in the database:
4671 - 13400 South & 4500 West - Phase: 0 (Missing Records)
5701 - 500 South & 400 East (Bri) - Phase: 0 (Missing Records)

--The following signals had too many force off occurrences:
1224 - North Temple & Main Street - Phase: 3 (Force Offs 97.6%)
7252 - 500 South & Main Street - Phase: 2 (Force Offs 100%)
7252 - 500 South & Main Street - Phase: 5 (Force Offs 100%)

--The following signals had too many max out occurrences:
1123 - Wolcott St & 100 South - Phase: 2 (Max Outs 100%)
1124 - Sunnyvale (950 S) & Gaardsman Way - Phase: 2 (Max Outs 100%)
1124 - Sunnyvale (950 S) & Gaardsman Way - Phase: 8 (Max Outs 100%)
4024 - 7000 South (Fort Union) & 1300 East - Phase: 7 (Max Outs 92.6%)
4029 - 7200 South & 700 East - Phase: 1 (Max Outs 100%)
4103 - 4680 South (Murray-Holladay) & 2300 East (Holladay) - Phase: 5 (Max Outs 100%)
4118 - 6200 South & 3655 West (Divie) - Phase: 2 (Max Outs 100%)
4511 - 4100 South & 3200 West - Phase: 4 (Max Outs 100%)
4620 - 4935 South & 2700 West - Phase: 2 (Max Outs 100%)
5063 - Lincoln & 24th - Phase: 4 (Max Outs 100%)
5063 - Lincoln & 24th - Phase: 8 (Max Outs 100%)
5080 - Washington & Adams - Phase: 5 (Max Outs 100%)
5170 - 200 N (Kaysville) & Main St. - Phase: 4 (Max Outs 100%)
5365 - Main St. & 200 North (Logan) - Phase: 7 (Max Outs 96.2%)
5900 - 500 W. (Kays Dr.) & 200 North, Kaysville - Phase: 4 (Max Outs 90.4%)
6033 - Pioneer Crossing & Millpond Drive - Phase: 8 (Max Outs 91.9%)
6688 - 100 West & 100 North - Phase: 8 (Max Outs 98.5%)
7107 - Redwood Road & 4700 South - Phase: 5 (Max Outs 93.2%)

--The following signals had unusually low detector hits:
5134 - SR-193 (700 S) & I-15 NB (Clearfield) - Phase: 2 (Has Unusually Low Counts)
7061 - Bangertet Hwy (SR-154) & 4100 South - Phase: 1 (Has Unusually Low Counts)
7061 - Bangertet Hwy (SR-154) & 4100 South - Phase: 7 (Has Unusually Low Counts)
7321 - Bangertet Hwy (SR-154) & 13400 South - Phase: 1 (Has Unusually Low Counts)

--The following signals have stuck ped detectors:
1023 - South Temple & 200 West - Phase: 2 (Stuck Ped)
1023 - South Temple & 200 West - Phase: 4 (Stuck Ped)
1023 - South Temple & 200 West - Phase: 6 (Stuck Ped)
1023 - South Temple & 200 West - Phase: 8 (Stuck Ped)
4511 - 4100 South & 3200 West - Phase: 4 (Stuck Ped)
6039 - Main (Lehi) & I-15 SPU - Phase: 6 (Stuck Ped)
7526 - 9800 S (Little Cottonwood Rd) & Wasatch Blvd (3500 E) - Phase: 4 (Stuck Ped)
Metric: Purdue Phase Termination
Detection Requirements: None

Too many max outs

Phase 4 starts constant call

SPMs evaluated for % max outs

Alert email sent

2014-04-08 00:00:00

2014-04-09 00:00:00

EDC
An Opportunity to Transform the Practice

Start
- Trigger
  - Complaints
  - 3-5 Year Retiming
- Design
  - Collect Data
  - Design
- Implement
  - Install
  - Fine Tune
  - Evaluate

Stop

Traditional

Recommended

Source: FHWA
Benefits

Transforms Maintenance and Operations Activity from Reactive to Proactive
- Lower Costs
- Higher Quality of Service to Customers
- Improved Safety and Efficiency

Improve Safety, Efficiency and Reliability
- Monitor Safety related performance measures
- Data driven allocation of green time
- Objectives & Performance Based Approach

Supports Asset Management
- Life Cycle Analysis
- Support for funding needs
Challenges

Organizational Capability

• Shift to Objectives & Performance from Ad-hoc Management
  o Business Processes not well Documented
  o Workforce
  o Systems & Technology
    – Signal Control
    – Communication
    – Detection

Dispersed Audience

• Connecting with Local Agencies
## Automated Traffic Signal Performance Measures State Implementation Goals

<table>
<thead>
<tr>
<th>State(s)</th>
<th>Initial Stage</th>
<th>Final Stage</th>
<th>Description of Final Implementation Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>AK, CA*, CT*, FLH, IL*, KS*, MO*, MS*, ND, NE, NV*, OK, SC, VI, (14)</td>
<td>Not Implementing</td>
<td>Not Implementing</td>
<td>The State is not currently using ATSPMs or interested in pursuing implementation.</td>
</tr>
<tr>
<td>HI, PR, WV (3)</td>
<td>Not Implementing</td>
<td>Development Stage</td>
<td>The State is interested in ATSPMs and intends to increase implementation readiness at State and/or local level through capacity building activities.</td>
</tr>
<tr>
<td>AR, AZ, CO, FL, IA, ID, KY, LA, MA, ME, MO, NC, NH, NM, OH, SD, VT, WA (18)</td>
<td>Development Stage</td>
<td>Demonstration Stage</td>
<td>The State or local agency(s) has or plans to advance a pilot implementation of ATSPMs and will assess one or more performance measures.</td>
</tr>
<tr>
<td>MI (1)</td>
<td>Demonstration Stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DE, MT, PA (3)</td>
<td>Development Stage</td>
<td>Assessment Stage</td>
<td>The State is beyond testing/piloting ATSPMs. ATSPMs are being actively implemented to monitor the performance of signalized intersections in one or more jurisdictions within the State and actively promoting full implementation on all signalized intersections where appropriate.</td>
</tr>
<tr>
<td>OR (1)</td>
<td>Demonstration Stage</td>
<td>Institutionalized</td>
<td>ATSPMs is adopted by the State’s transportation community to support an objectives and performance based approach to maintenance, operation management and design of signalized intersections.</td>
</tr>
<tr>
<td>NJ, TN, WY(3)</td>
<td>Development Stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AL, MN, VA (3)</td>
<td>Demonstration Stage</td>
<td>Institutionalized</td>
<td></td>
</tr>
<tr>
<td>IN, RI, WI (3)</td>
<td>Assessment Stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GA, UT (2)</td>
<td>Institutionalized</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*ATSPM Implementation Currently Active*
EDC-4/ATSPM State Implementation Goals

Implementation Stage
- Not Implementing
- Development
- Demonstration
- Assessment
- Institutionalized
- Local Agency Deployment
Transportation Pooled Fund Study 5-528
http://www.pooledfund.org/Details/Study/487

- Publications

AASHTO innovation initiative
http://aii.transportation.org/Pages/AutomatedTrafficSignalPerformanceMeasures.aspx

ATSPM Workshop Proceedings 1/2016
http://docs.lib.purdue.edu/atspmw/2016/
Questions?

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