AUTOMATED TRAFFIC SIGNAL PERFORMANCE MEASURES

ITS California
Technical Session 9 - Innovative Technology for Local Cities
Thursday, October 16, 2014

Mark Taylor, P.E., PTOE
Traffic Signal Operations Engineer
Utah Department of Transportation
marktaylor@utah.gov
Utah - Brief Facts

- 1908 Traffic Signals in the State of Utah
  - 1151 owned and operated by UDOT (60%)
  - 757 owned and operated by cities /counties (40%)

- All cities share same ITS communications
  - 88% of UDOT signals connected
  - 79% of non-UDOT signals connected

- All cities in Utah & UDOT share same ATMS
PERFORMANCE MEASURES FOR TRAFFIC SIGNAL SYSTEMS

An Outcome-Oriented Approach

System Requirements for SPM’s

1) High-resolution Controller
- Econolite Cobalt: Any Version
- Econolite ASC3 NEMA: V. 2.50+ & OS 1.14.03+
- Econolite 2070 with 1C CPU Module: V. 32.50+
- Intelight Maxtime: V. 1.7.0+
- Peek ATC Greenwave 03.05.0528+
- Trafficware 980ATC V. 76.10+
- Siemens M50 Linux & M60 ATC
  - ECOM V. 3.52+
  - NTCIP V. 4.53+
- McCain – In Progress

2) Communications

3) Server

4) Website

5) Detection (optional)

Can be done independent of a central system!
### Types of Performance Metrics

<table>
<thead>
<tr>
<th>Controller high-resolution data only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purdue Phase Termination</td>
</tr>
<tr>
<td>Split Monitor</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Advanced Count Detection (~350 - 400 ft behind stop bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purdue Coordination Diagram</td>
</tr>
<tr>
<td>Approach Volume</td>
</tr>
<tr>
<td>Platoon Ratio</td>
</tr>
<tr>
<td>Arrivals on Red</td>
</tr>
<tr>
<td>Approach Delay</td>
</tr>
<tr>
<td>Executive Summary Reports</td>
</tr>
<tr>
<td>Link Pivot (future)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Advanced Detection with Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach Speed <em>(Wavetronix Advance)</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lane-by-lane Presence Detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Split Failure (future)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lane-by-lane Count Detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turning Movement Counts</td>
</tr>
<tr>
<td>Red Light Monitoring (future)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Probe Travel Time Data (GPS or Bluetooth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purdue Travel Time Diagram</td>
</tr>
</tbody>
</table>

All detectors (except speed metric) can be radar, loops, video, pucks – it doesn’t matter.
How Phases Terminate by Time-of-Day

8-phase signal with working detection

Metric: Purdue Phase Termination Chart
Detection Requirements: None
Maintenance Example: 
Nighttime detection problem

**BEFORE:** Video detection not working at night

Minor street through & left turn max out at night only

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

**Metric:** Purdue Phase Termination Chart

Detection Requirements: None
Maintenance Example: Nighttime detection problem

BEFORE: Video detection not working at night

**Major Street (Ø2)**

- 20s of green
- 30s of red

**Minor Street (Ø4)**

- Pedestrian activation
  - (shown above phase line)

Metric: Split Monitor

Detection Requirements: None
Maintenance Example: Nighttime detection problem

AFTER: Detection repaired

Phases are rarely used at night

Metric: Purdue Phase Termination Chart
Detection Requirements: None
Coordination Optimization Example: Progression Quality

One approach shown

Vehicles arrive on green
Vehicles arrive on yellow
Vehicles arrive on red

Metric: Purdue Coordination Diagram
Detection Requirements: Advance Counters
Approach Volumes

- When to take a lane for maintenance
- Directional splits for offset optimization
- Network models
Lane-by-Lane Volume Counts
Use for traffic studies, models, adjust splits, coordination balance

**Metric: Turning Movement Counts**
Detection Requirements: Stop Bar Counters
Measuring Corridor Travel Time – Cumulative Frequency

Before & after corridor evaluations using historical GPS travel time data from INRIX

**Before Condition:** SB Bangerter Hwy: SR-201 to 7000 S, SLC, UT – March 2013

**After Condition:** SB Bangerter Hwy: SR-201 to 7000 S, SLC, UT – May 2013

- **Bangerter Hwy:** SR-201 to 7000 S, Southbound
- Length: 9.5 miles
- 1 DDI
- 7 CFIs
- 4 8-phase signals

**Metric:** Purdue Travel Time Diagram

**Detection Requirements:** Probe Data Set
Metric 1: Purdue Coordination Diagram
Detection Requirements: Advance

Metric 2: Purdue Travel Time Diagram
Requirements: Probe data set

Corridor PM Peak Arrival on Green
23%
19%
57%

Initial Percent Arrival on Green
Increase in Percent Arrival on Green
Decrease in Percent Arrival on Green
Executive Reports & Prioritizing

➢ Are signal operations improving, staying the same, or getting worse and by how much?
➢ How does an agency most effectively prioritize resources and workload?
➢ What are our areas of most need?

Statewide Summary 24 hours / day in Utah for September 2014

<table>
<thead>
<tr>
<th>Month</th>
<th>Arrival on Red</th>
<th>Volume</th>
<th>Intersections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Daily Average Per Approach</td>
<td>Total</td>
</tr>
<tr>
<td>Sept. 2014</td>
<td>29%</td>
<td>1.17</td>
<td>10,922</td>
</tr>
</tbody>
</table>

➢ Region, corridor, and intersection summaries also available.
   ➢ Prioritize coordination projects where they’re needed the most.

➢ Engineers could now **directly measure** what previously they could only **estimate and model**.

**Metric:** Executive Reports
**Detection Requirements:** Advance Counters
Automated Traffic Signal Performance Measures

AASHTO Innovation Initiative (formally TIG)  
2013 Focus Technology

Mission: Investing time and money to accelerate technology adoption by agencies nationwide

Please let UDOT know if you’re interested in pursuing this technology as we’re donating the source code for free to others.
Mark Taylor
marktaylor@utah.gov
udottraffic.utah.gov/signalperformancemetrics