Improving Operations with Automated Traffic Signal Performance Measures

Tennessee Section of ITE 2017 Spring Meeting

Franklin, TN

May 23, 2017
National Traffic Signal
Report Card 2012

<table>
<thead>
<tr>
<th>Category</th>
<th>Grade</th>
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</thead>
<tbody>
<tr>
<td>Management</td>
<td>D</td>
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<tr>
<td>Traffic Signal Operations</td>
<td>C</td>
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<tr>
<td>Signal Timing Practices</td>
<td>C</td>
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<tr>
<td>Traffic Monitoring</td>
<td>F</td>
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<tr>
<td>Traffic Monitoring and Data Collection</td>
<td></td>
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<tr>
<td>Maintenance</td>
<td>C</td>
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</tbody>
</table>

**OVERALL** D+

Source: National Transportation Operations Coalition
Resources

Consultants, academia, contractors, MPO’s, RPO’s, etc, etc, ...
Opportunity to coordinate efforts and transform the practice! From reactive to proactive.
ATSPM
Automated Traffic Signal Performance Measures
Background
A Fitness Tracker for Traffic Signals

High Resolution Data Collection

Data Analysis and Performance Report Tools

September 3, 2016

16,771 steps

46 floors 6.71 miles 4,303 cals 155 minutes

Source: FHWA
System Requirements

High-resolution Controller

Communications

Server

Software

Detection

Photo courtesy of the Indiana Department of Transportation
Events Codes

Active Phase Events:
- 0  Phase On
- 1  Phase Begin Green
- 2  Phase Check
- 3  Phase Min Complete
- 4  Phase Gap Out
- 5  Phase Max Out
- 6  Phase Force Off
- 7  Phase Green Termination
- 8  Phase Begin Yellow Clearance
- 9  Phase End Yellow Clearance
-10  Phase Begin Red Clearance
-11  Phase End Red Clearance

Detector Events:
- 81  Detector Off
- 82  Detector On
- 83  Detector Restored
- 84  Detector Fault - Other
- 85  Detector Fault - Watchdog Fault
- 86  Detector Fault - Open Loop Fault

Preemption Events:
-101 Preempt Advance Warning Input
-102 Preempt (Call) Input On
-103 Preempt Gate Down Input Received
-104 Preempt (Call) Input Off
-105 Preempt Entry Started
## High Resolution Data

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<thead>
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<th>Timestamp</th>
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<th>Event Parameter</th>
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<td>6/27/2013 1:30:30.4</td>
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</tbody>
</table>

Source: Purdue University
High Resolution Data – Vendor Neutrality

High-resolution Controller with built in data logger using Indiana Enumerations

- Econolite Cobalt: Any Version
- Econolite ASC3 NEMA: V. 2.50+
- Econolite 2070 with 1C CPU Module: V. 32.50+
- Intellight Maxtime: V. 1.7.0+
- Peek ATC Greenwave 03.05.0528+
- Trafficware 980ATC V. 76.10+
- McCain ATC eX NEMA: V. ?
- Siemens M50 Linux & M60 ATC
  - ECOM V. 3.52+
  - NTCP V. 4.53+

Data Logger records to the 1/10 second resolution

Source: Utah DOT
High Resolution Data
Progression Quality

The PCD’s are instrumental in optimizing offsets, identifying oversaturated or under saturated splits for the coordinated phases, the effects of early return of green and coordinated phase actuations, impacts of queuing, adjacent signal synchronization, etc.
Progression Quality

How do we typically fine tune offsets today?
Floating car runs,…
<table>
<thead>
<tr>
<th>Detection information needed</th>
<th>Metric</th>
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<tbody>
<tr>
<td>None</td>
<td>Phase Termination Chart</td>
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<tr>
<td></td>
<td>Split Monitor</td>
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<tr>
<td></td>
<td>Preemption Details</td>
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<tr>
<td></td>
<td>Pedestrian Delay</td>
</tr>
<tr>
<td>Lane-by-lane Presence Lane Group Presence</td>
<td>Purdue Split Failure</td>
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<tr>
<td>Lane-by-lane Stop Bar Count</td>
<td>Turning Movement Counts</td>
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<tr>
<td>Advanced Count</td>
<td>Purdue Coordination Diagram</td>
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<td>Approach Volume</td>
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<td></td>
<td>Approach Speed (requires detection with speed service)</td>
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</table>
Phase Termination Chart

- Minor street through & left turn max out at night only
- Phases are rarely used at night

Source: Purdue University
Alert Example: 100% Max Out

Daily email at 7 a.m.
- Uses Purdue Phase Termination chart data
- Flags phases with >90% max-outs on each phase between 1 a.m. and 5 a.m.
- Compare to previous day’s list. Only phases with new flags are sent in the email.

Source: Utah DOT
Split Monitor (amount of time left)
Preemption Details

Preempt Service Chart
SIG#0057 Geneva Rd & 200 S (Lindon)
Wednesday, May 25, 2016, 9:00 AM to 4:00 PM

56 Preempt Requests & Services in 70 minutes
Gate down 35% of the time

- Train passes through 2x a day Monday, Wednesday, Friday
- Complaints received monthly for a long time. Techs frustrated at this signal.
- Previously, there was no data to provide Union Pacific.
Pedestrian Delay

Event Codes:
45 – Ped Call on
21 – Ped Walk on

Source: Purdue University
Turning Movement Counts, Lane Utilization (construction activities)

Source: Purdue University
Approach Volumes

Enhance MPO’s, RPO’s, TPO’s data!
Approach Speed

Bluff & 100 S, St. George, NB

Source: Purdue University
Approach Speed (change of timing plans)

Source: Purdue University
Approach Delay

Detection Requirements: Approach counts

Approach Delay
Approach Delay Per Vehicle

University Avenue @ East Bay Boulevard Signal 6402 Phase: 2 Northbound
Tuesday, January 17, 2017 12:00 AM - Tuesday, January 17, 2017 11:59 PM

Average Delay Per Vehicle = 13 Seconds,
Total Delay For Selected Period = 175416 Seconds

Free
3 AD
3388 TD

Plan 1
6 AD
14554 TD

Plan 7
15 AD
71330 TD

Plan 13
21 AD
72529 TD

Plan 7
10 AD
15272 TD

Plan 19
4 AD
1339 TD

Simplified Approach Delay. Displays time between approach activation during the red phase and when the phase turns green.
Does NOT account for start up delay, deceleration, or queue length that exceeds the detection zone.

Source: Utah DOT
The algorithm works by stepping through possible offsets at each intersection while trying to find the minimum delay or maximum arrivals on green.
Purdue Link Pivot

Offset Optimization - BEFORE

Int. 5 (146th St.)
Int. 6 (141st St.)
Int. 7 (131st St.)
Int. 8 (126th St.)

SB

NB

Bad

Source: Purdue University
Purdue Link Pivot

Offset Optimization – AFTER

Int. 5 (146th St.)

Int. 6 (141st St.)

Int. 7 (131st St.)

Int. 8 (126th St.)

Source: Purdue University
ATSPM In Practice

Source: GDOT
State Efforts

- Collaboration with the City of Knoxville (ATMS)
- Focus on arterials
- TDOT/FHWA identifying additional potential local agencies
- TN Traffic Signal Users Group

Challenges:
- Detection
- $$$
- Using the data
- Asset management tool
- Aids timing and coordination
- Assists planning, justify investments
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Thank You!