AUTOMATED TRAFFIC SIGNAL PERFORMANCE MEASURES

RM3: More than Raw Data – Using Performance Measures to Direct System Improvements

National Rural ITS Conference – Snowbird, Utah
Monday, August 10th, 2015

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Utah - Brief Facts

- 1954 Traffic Signals in the State of Utah
  - 1163 owned and operated by UDOT (60%)
  - 791 owned and operated by cities /counties (40%)

- All cities share same ITS communications
  - 90% of UDOT signals connected
  - 80% of non-UDOT signals connected

- All cities in Utah & UDOT share same ATMS
Utah Demographics

- 13\textsuperscript{th} largest, 33\textsuperscript{rd} most populous, 10\textsuperscript{th} least densely populated.
- Population 2.9 million
  - 80\% live along Wasatch Front
  - Population to double by 2050.

RURAL Utah
- 87 traffic signals (7.5\%)
- 37 signals connected (43\%)
  - Within 12 months 30 more (75\%)
UDOT's Fiber Optic Network

- **Trade Miles - Fiber/Conduit/Circuit**
- **UDOT Fiber/Conduit Miles**
- **Trade Value**

Cumulative Trade Values for Conduit/Fiber/Circuits

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Combined Fiber/Conduit/Circuit Miles</th>
<th>Miles</th>
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<tbody>
<tr>
<td>2001</td>
<td>300</td>
<td>600</td>
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<td>2004</td>
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<td>1200</td>
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<td>2005</td>
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<td>1400</td>
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<td>2006</td>
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<td>2011</td>
<td>2300</td>
<td>2600</td>
</tr>
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<td>2012</td>
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<td>2700</td>
<td>3000</td>
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<tr>
<td>2014</td>
<td>2900</td>
<td>3200</td>
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</table>
Opportunity – UDOT Executive Leaders - 2011

“What would it take for UDOT’s traffic signals to be World-Class?”

“What’s the trend – are signal operations improving, staying the same or getting worse?”

“What are our areas of most need?”

John Njord

Carlos Braceras
Some QIT Recommendations (July 2011)

- Require that communications and signal detection be maintained during projects.
- Transition from reactive to proactive signal maintenance by increasing signal maintenance funding.
- Implement real-time monitoring of system health and quality of operations.
  - Automated Traffic Signal Performance Measures (SPM’s)
    http://udottraffic.utah.gov/performance.metrics/
PERFORMANCE MEASURES FOR TRAFFIC SIGNAL SYSTEMS

An Outcome-Oriented Approach

SPM Basic Concept

Automated Data Collection
- Signal controller
- Probe source

Useful Information about Performance
- Signal
- Corridor
- System

A Central Signal System is NOT used or Needed for these SPM’s.
Types of Performance Metrics

**Controller high-resolution data only**
- Purdue Phase Termination
- Split Monitor
- Pedestrian Delay (future)

**Advanced Count Detection (~400 ft behind stop bar)**
- Purdue Coordination Diagram
- Approach Volume
- Platoon Ratio
- Purdue Link Pivot

**Advanced Detection with Speed**
- Approach Speed *(Wavetronix Advance)*

**Lane-by-lane Count Detection**
- Turning Movement Counts
- Red Light Monitoring

**Lane-by-lane Presence Detection**
- Purdue Split Failure (future)

**Probe Travel Time Data (GPS or Bluetooth)**
- Purdue Travel Time Diagram

*All detectors (except speed metric) can be radar, loops, video, pucks – it doesn’t matter.*
Purdue Phase Termination

How Phases Terminate by Time-of-Day

8-phase signal with working detection

Metric: Purdue Phase Termination Chart
Detection Requirements: None
Split Monitor

Monitoring Duration of Greens by Time-of-Day

1 of 8 phases shown

300 West 600 North SIG#7122 Phase 4
Wednesday, September 03, 2014 12:00 AM - Wednesday, September 03, 2014 11:59 PM

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
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<td>15.2 - 85 Percentile Split</td>
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<tr>
<td>Plan 1</td>
<td>42.7 - 85 Percentile Split</td>
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<tr>
<td>Plan 10</td>
<td>49.6 - 85 Percentile Split</td>
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<td>Plan 13</td>
<td>42.5 - 85 Percentile Split</td>
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<td>Pli</td>
<td>37.0 - 85 Percentile Split</td>
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<tr>
<td>Free</td>
<td>19.9 - 85 Percentile Split</td>
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<tr>
<td>14.0 Avg. Split</td>
<td>32.5 Avg. Split</td>
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<tr>
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<td>16.4 Avg. Split</td>
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<td>0.5% MaxOuts</td>
<td>0.7% MaxOuts</td>
</tr>
<tr>
<td>98.4% GapOuts</td>
<td>91.8% GapOuts</td>
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<td>98.4% GapOuts</td>
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<tr>
<td>0.5% Skips</td>
<td>4.4% Skips</td>
</tr>
</tbody>
</table>

Graph showing phase duration (seconds) against time (hour of day) with markers for gap out, pedestrian activation, max out, and force off.

Metric: Split Monitor
Detection Requirements: None
Approach Volumes
When to Take a Lane for Maintenance Activities, Directional Splits, Traffic Models

Metric: Approach Volumes
Detection Requirements: Advance Counters
Approach Speeds
Use for Traffic Studies, Severe Weather Timing Plans, and Calculating Yellow and Red Clearance Intervals

Bluff St. & 100 S., St. George, Utah – North Bound

Metric: Approach Speeds
Detection Requirements: Wavetronix Advance Radar
Lane-by-Lane Volume Counts

Use for traffic studies, models, adjust splits, coordination balance

Metric: Turning Movement Counts
Detection Requirements: Stop Bar Counters
Red Light Monitoring

Use for identifying safety trends and engineering countermeasures

Metric: Red Light Monitoring
Detection Requirements: Stop Bar Counters with speed filter or detectors in intersection
Purdue Coordination Diagram

Evaluating progression quality – Are vehicles arriving on green or red?

Southbound Direction

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

Metric: Purdue Coordination Diagram
Detection Requirements: Advance Counters
Purdue Link Pivot
Automatically optimizing offsets along a corridor

**Metric: Purdue Link Pivot**

**Detection Requirements:** Advance Counters
Statewide Percentage of Vehicles Arriving on Green Monday thru Friday 24/7

Metric: Executive Reports
Detection Requirements: Advance Counters

% Vehicles Arriving on Green

Number of Signals in Sample

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

2013  2014  2015

2013  2014  2015
Heavy rain rips apart I-15 in Nevada, forces freeway closure

By Ken Ritter, Michelle Rindels, Associated Press | Posted Sep 9th, 2014 @ 7:44pm
September 9, 2014 – September 12, 2014

- I-15 Closed Southbound in Nevada for 4 days.
- Detour thru Rural Cedar City
- Used ATMS
  - Signals on central system
    - Max Recall adj. signal – Provide gaps on the permissive left.
    - Increased green time.
  - CCTV, VMS, IMT, HAR
Optimization Example: Emergency Freeway Closure

Phase 4 shown – Freeway off-ramp
One week of data

Normal Traffic on Sunday and Monday

Increased traffic beginning Tuesday morning and Friday after split due to freeway washout in Nevada as shown by more frequent gap-out and higher split being used

Detection Requirements: None
Why Model What You Can Measure?

“Our success will not be measured by how much data we collect, but instead how we use the data to improve the operation of our transportation network.”

– Steve Kuciemba - Parsons Brinckerhoff

“Well measured results that show a high return-on-investment is the key to receiving additional resources and sustained support.”

– Mark Taylor – Utah Department of Transportation
Automated Signal Performance Measures

*Purdue & INDOT helped us, in turn, we would like to help you.*

- 2014 Project of the Year
- 2013 Quality Award
- 2013 Focus Technology
- 2014 Governor’s Award of Excellence – Innovation and Efficiency
Automated Traffic Signal Performance Measures

udottraffic.utah.gov/signalperformancemetrics