PERFORMANCE MEASURES FOR TRAFFIC SIGNAL MAINTENANCE

Jay Grossman, Elkhart County Highway Department
Outline:

• **Background and Motivation**

• **Pedestrian Calls**
  • Operational Verification
  • Methodology
  • Call Button Error Detection

• **Vehicle Detector Analysis**
  • Methodology
  • Case Studies
  • Conclusions
Maintenance Performance Measures
Developed on two local agency systems in Indiana

Mishawaka
- 64 signals
- 37 reporting
- 22 with peds
- 1181 detection channels
- 6.6 M records per day

Elkhart County
- 29 signals
- 21 reporting
- 3 with peds
- 671 detection channels
- 2.7 M records per day
Performance Measures Converted to Specifications

Equivalent Hourly Flow Rate

Volume to Capacity Ratio

Split Failures Per Half Hour

Purdue Coordination Diagram (PCD)

Percentage of Phases with Peds
Reports generated within central system

First used within central system in 2011
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- Background and Motivation
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  - Call Button Error Detection
- Vehicle Detector Analysis
  - Methodology
  - Case Studies
  - Conclusions
Pedestrian Calls
Operational Verification

Some phases are rarely activated. Still working?

Staff activated each call button, logs used for operational verification.
Methodology:

- Use Historic Data for a sensor channel to develop base lines of ‘normal’ behavior
- Plot current period activity
- Identify potential errors
Methodology:

- Use Historic Data for a sensor channel to develop base lines of ‘normal’ behavior
- **Plot current period activity**
- Identify potential errors
Methodology:

- Use Historic Data for a sensor channel to develop base lines of ‘normal’ behavior
- Plot current period activity
- **Identify potential errors**
Mishawaka: pedestrian call analysis

Main and Mishawaka Ped Calls, Week 1

Calls

Date

June-14

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Mishawaka: pedestrian call analysis
Mishawaka: pedestrian call analysis
Mishawaka: pedestrian call analysis

Main and Mishawaka Ped Calls, Week 4

Calls

Average

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July-14

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Mishawaka: pedestrian call analysis
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July-14

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Mishawaka: pedestrian call analysis

4th of July, adjacent to a park on riverfront, not an error
Outline:

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• Vehicle Detector Analysis
  • Methodology
  • Case Studies
  • Conclusions
Vehicle Detector Analysis
Methodology: Base Line

1 Week of Data
Vehicle Detector Analysis
Methodology: Base Line

2 Weeks of Data
Vehicle Detector Analysis
Methodology: Base Line

3 Weeks of Data
Vehicle Detector Analysis
Methodology: Base Line

4 Weeks of Data
Vehicle Detector Analysis
Methodology: Base Line

Three weeks of data for base line creation has worked best in our analysis. Four weeks adds little extra detail for error identification.

Computationally, entire system of more than 1100 detection channels can be analyzed in less than 5 minutes.
Vehicle Detector Analysis
Methodology: Error Threshold

Minimize false error alerts

Standard Deviation $\geq 1.5$

Standard deviation threshold better as a user definable value due to range of normal calls for various detectors within system. 1.5—2.0 is generally a good range.
Case Study: CR 14 January error event

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CR14 Detector 12

January 2014

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CR14 Detector 12

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CR14 Detector 12

January 2014

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Case Study: CR 14 January error event

Look at week of 1/19 with error analysis

Unusual pattern of intermittent errors, generally early morning
Case Study: CR 14 January error event

CR14 Detector 12

Found bad cable, intermittently failing—apparently temperature related. Fixed at this time
Case Study: CR 14 January error event
## Case Study: March 12, 2014 Snow Event

### Heavy, wet snow blowing from the North, covering lenses and signal indications

<table>
<thead>
<tr>
<th>Time (EDT)</th>
<th>Temp.</th>
<th>Dew Point</th>
<th>Visibility</th>
<th>Wind Dir</th>
<th>Wind Speed</th>
<th>Precip</th>
<th>Events</th>
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<td>37.9°F</td>
<td>35.1°F</td>
<td>8.0 mi</td>
<td>NNE</td>
<td>10.4 mph</td>
<td>0.00 in</td>
<td>Rain</td>
<td>Light Rain</td>
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<td>1:53 AM</td>
<td>37.9°F</td>
<td>35.1°F</td>
<td>10.0 mi</td>
<td>NNE</td>
<td>10.4 mph</td>
<td>0.01 in</td>
<td>Rain</td>
<td>Light Rain</td>
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<td>2:53 AM</td>
<td>37.9°F</td>
<td>35.1°F</td>
<td>10.0 mi</td>
<td>NE</td>
<td>13.8 mph</td>
<td>0.00 in</td>
<td>Overcast</td>
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<td>3:53 AM</td>
<td>36.0°F</td>
<td>33.1°F</td>
<td>10.0 mi</td>
<td>NE</td>
<td>20.7 mph</td>
<td>N/A</td>
<td>Overcast</td>
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<tr>
<td>4:53 AM</td>
<td>34.0°F</td>
<td>32.0°F</td>
<td>0.8 mi</td>
<td>North</td>
<td>-</td>
<td>0.06 in</td>
<td>Snow</td>
<td>Light Snow</td>
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<td>5:53 AM</td>
<td>33.1°F</td>
<td>32.0°F</td>
<td>0.2 mi</td>
<td>North</td>
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<td>0.08 in</td>
<td>Fog , Snow Heavy Snow</td>
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<td>6:53 AM</td>
<td>32.0°F</td>
<td>28.9°F</td>
<td>0.5 mi</td>
<td>North</td>
<td>-</td>
<td>0.03 in</td>
<td>Fog</td>
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<td>7:53 AM</td>
<td>30.9°F</td>
<td>28.0°F</td>
<td>0.5 mi</td>
<td>North</td>
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<td>0.02 in</td>
<td>Fog , Snow Snow</td>
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<td>0.5 mi</td>
<td>North</td>
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<td>0.01 in</td>
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Photo: Elkhart Truth
Case Study: March 12, 2014 Snow Event

Beck Intersection Video Detection

SB Detector 18

NB Detector 22
Case Study: March 12, 2014 Snow Event

Beck Intersection Video Detection

Beck Detector 22

Detector Calls

Facing South

NB Detector 22
Case Study: March 12, 2014 Snow Event

Beck Intersection Video Detection

Beck Detector 18

Facing North

SB Detector 18
Case Study: March 12, 2014 Snow Event

Beck Intersection Video Detection

Detector Calls

Facing North

SB Detector 18

Compare with historic ‘Normal’ values to trigger system alerts
System Didn’t Report Any Detection Errors
Case Study: CR 4 Loop failure
Case Study: CR 4 Loop failure

August-14

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Case Study: CR 4 Loop failure
Case Study: CR 4 Loop failure
Case Study: CR 4 Loop failure

Pothole, lead-in exposed

Loop removed from series

Labelled for repair
Case Study: CR 4 Loop failure

Post-repair counts flagged because while out of service, the average was degraded. A ‘false positive’ situation
Conclusions

Maintenance performance measures can be used to verify operation of call buttons.

Can be used to identify potential call button errors.
Conclusions

Maintenance performance measures can be used to identify intermittent errors that equipment failure reports may not can be used to identify traditional failures.

Three weeks of data for base line creation and a standard deviation of 1.5—2.0 worked well in study for error determination.
Conclusions

Performance measures allow local agencies to more effectively manage signal systems with limited staffing.

Find errors before this:
This work was sponsored by:

Indiana LTAP

and the

Joint Transportation Research Program at Purdue University