Traffic Signal Performance Measures

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Joint Transportation Research Program Director
Purdue University

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darcy@purdue.edu
Team Effort
High Resolution Controller Data

Probe Data

Opportunities to Better Leverage Existing Infrastructure
Enormous opportunities to fuse/validate traffic signal data with probe data sources

What gets measured gets done, what gets measured and fed back gets done well, what gets rewarded gets repeated.
– John E. Jones

Opportunities to Push the State of the Possible
Hi Resolution Data is Critical for Identifying Levers

- Efficient Coordination
- Efficient Local Control
- Detector Health
- Working Communications

Coordination

Timing

Detection

Communications

OPERATIONS

MAINTENANCE
Probe Data is integral for Outcome Assessment

- Efficient Coordination
- Efficient Local Control
- Detector Health
- Working Communications
Efficient Coordination
Efficient Local Control
Detector Health
Working Communications

Advanced Control
Coordination
Timing
Communication
Detection

OPERATIONS
MAINTENANCE
Critical Performance Measures for Managing Signals

1. Is my communication working?
2. Are my detectors working?
3. Do I have adequate green time on each phase?
4. Do I have most of my vehicles arriving on green?

*Write this Down if you agree!*
# Portfolio of Performance Measures

<table>
<thead>
<tr>
<th>MOE</th>
<th>Usage</th>
<th>Documented in Monograph</th>
<th>Journal Papers (DOI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle Length</td>
<td>Verify consistent controller programming along corridor, and quickly evaluate performance of fully-actuated signals</td>
<td>✓</td>
<td>10.3141/2128-05</td>
</tr>
<tr>
<td>Green Time and Capacity</td>
<td>Verify controller behavior</td>
<td>✓</td>
<td>10.3141/2035-11</td>
</tr>
<tr>
<td>Count and Volume</td>
<td>Characterize vehicle demand by movement</td>
<td>✓</td>
<td>10.3141/2035-11</td>
</tr>
<tr>
<td>Volume-to-Capacity Ratio</td>
<td>Evaluate utilization of provided capacity</td>
<td>✓</td>
<td>10.3141/2035-11</td>
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<tr>
<td>Degree of Intersection Saturation</td>
<td>Evaluate overall intersection utilization</td>
<td>✓</td>
<td>10.3141/2128-05</td>
</tr>
<tr>
<td>Percent on Green, Arrival Type</td>
<td>Evaluate progression performance</td>
<td>✓</td>
<td>10.3141/2035-11</td>
</tr>
<tr>
<td>Purdue Coordination Diagram</td>
<td>Visualize progression performance over a variety of time-scales</td>
<td>✓</td>
<td>10.3141/2192-04, 10.3141/2259-06</td>
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<tr>
<td>Platoon / Flow Profile</td>
<td>Visualize progression performance for a given time period where a consistent cycle length occurs</td>
<td>✓</td>
<td>10.3141/2259-02</td>
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<tr>
<td>Estimated Queue Length</td>
<td>Estimate lengths of queues at intersections</td>
<td>✓</td>
<td>10.1016/j.trc.2009.02.003</td>
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<td>Oversaturation Severity Index</td>
<td>Evaluate spatial and temporal characteristics of oversaturation in the street network</td>
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<td>10.1016/j.trc.2010.01.003</td>
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<td>Input-Output Delay</td>
<td>Estimate delay experienced by vehicles on movements where advance detection exists</td>
<td>✓</td>
<td>10.3141/2035-08.</td>
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<td>Maximum Vehicle Delay</td>
<td>Estimate delay experienced by vehicles on movements where stop bar detection exists</td>
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<td>TRB Paper # 15-0385</td>
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<tr>
<td>Estimated Vehicle HCM Delay</td>
<td>Estimate delay experienced by vehicles based on HCM methodology</td>
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</table>
## Portfolio of Performance Measures (p. 2)

<table>
<thead>
<tr>
<th>MOE</th>
<th>Usage</th>
<th>Documented in Monograph</th>
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<tbody>
<tr>
<td>Phase Termination Diagram</td>
<td>Visualize utilization of actuated phases</td>
<td>✔</td>
<td>10.3141/2355-03</td>
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<tr>
<td>Green Occupancy Ratio and Red Occupancy Ratio (ROR/GOR)</td>
<td>Estimate occurrence split failures where stop bar detection exists</td>
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<td>Platoon Characteristics</td>
<td>Estimate Robertson model parameters of vehicle platoons</td>
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<td>Coordination Optimization Potential</td>
<td>Estimate potential gains from adjusting signal timing for progression</td>
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<td>(Unpublished)</td>
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<td>Pedestrian Actuation Rate</td>
<td>Estimate utilization of intersection by pedestrians</td>
<td>✔</td>
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<td>Pedestrian Actuation to Service Time</td>
<td>Estimate delay experienced by pedestrians</td>
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<td>Estimated Pedestrian HCM delay</td>
<td>Estimate delay experienced by pedestrians based on HCM methodology</td>
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<td>Pedestrian Conflicting Volume</td>
<td>Help determine effectiveness of pedestrian treatments</td>
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<td>Preempt Duration</td>
<td>Estimate amount of time that intersection is running limited service during preemption</td>
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<tr>
<td>Preemption Event Diagram</td>
<td>Validate preemption operation</td>
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<tr>
<td>Priority Time to Green</td>
<td>Characterize effectiveness of transit signal priority (or other forms of priority based control)</td>
<td>✔</td>
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<td>Controller Ping Response</td>
<td>Maintain communication systems</td>
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<td>10.3141/2355-03</td>
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<td>Data Completeness</td>
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<td>Detector Failure Heat Map</td>
<td>Maintain detection systems</td>
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<td>Corridor Travel Time</td>
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<tr>
<td>Segment Speed</td>
<td>Evaluate performance of a corridor signal system</td>
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Split Failure

SPLIT FAILURE
Overview of Study Intersection
Trailer Camera Setup and Study Schedule

JUNE 2013

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<tr>
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JULY 2013

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</table>

= Before Split Adjustment
= After Split Adjustment

Initial Data Collection and Analysis

Before/After Comparison

Trailer Camera
**Phase 7 Extension Timer**

Extension Timer = 3.0 seconds

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<table>
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<tbody>
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<td>φ5</td>
<td>φ6</td>
<td>φ7</td>
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<tr>
<td></td>
<td></td>
<td>φ8</td>
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</table>
ROR₅ vs. GOR for an Undersaturated Split (Phase 7)

Start of Green (9:30:24.1)

Detector 5

Detector 5 On
Detector 5 Off

Occupancy Ratios

Phase 7

Calculation Illustration of GOR and ROR₅
ROR$_5$ vs. GOR for an Undersaturated Split (Phase 7)
ROR₅ vs. GOR for an Undersaturated Split (Phase 7)

Detector 5 On
Detector 5 Off
Occupy Ratios
Phase 7

Calculation Illustration of GOR and ROR₅
ROR₅ vs. GOR for an Undersaturated Split (Phase 7)
ROR₅ vs. GOR for an Undersaturated Split (Phase 7)
ROR_5 vs. GOR for an Undersaturated Split (Phase 7)
ROR_{5} vs. GOR for an Undersaturated Split (Phase 7)
ROR$_5$ vs. GOR for an Undersaturated Split (Phase 7)
ROR₅ vs. GOR for an Undersaturated Split (Phase 7)

Detector 5

Detector 5 On
Detector 5 Off

Occupancy Ratios

Phase 7
ROR$_5$ vs. GOR for an Undersaturated Split (Phase 7)

Start of Yellow (9:30:33.1)

Calculation Illustration of GOR and ROR$_5$
ROR₅ vs. GOR for an Undersaturated Split (Phase 7)
ROR$_5$ vs. GOR for an Undersaturated Split (Phase 7)
ROR_5 vs. GOR for an Undersaturated Split (Phase 7)
ROR$_5$ vs. GOR for an Undersaturated Split (Phase 7)
ROR$_5$ vs. GOR for an Undersaturated Split (Phase 7)
ROR₅ vs. GOR for an Undersaturated Split (Phase 7)

Detector 5

Detector 5 On
Detector 5 Off

Occupancy Ratios

Phase 7

Calculation Illustration of GOR and ROR₅
ROR$_5$ vs. GOR for an Undersaturated Split (Phase 7)

5 Seconds After Start of Red (9:30:41.6)

Calculation Illustration of GOR and ROR$_5$
GOR = 67%

ROR5 = 0%

ROR5 vs. GOR for an Undersaturated Split (Phase 7)
ROR$_5$ vs. GOR for an Undersaturated Split (Phase 7)
ROR₅ vs. GOR Plot for an Undersaturated Left Turn

ROR₅ vs. TOD (0900-1000)

GOR vs. TOD (0900-1000)

ROR₅ vs. GOR (0900-1000)

= Force offs

= Gap outs
Split Failure for 8 Street and 7 Avenue Northbound - Through

Sep 14th 2016
Metric: Purdue Split Failure

700 East 900 South Signal 7184 Phase: 6 Southbound
Wednesday, April 27, 2016 12:00 AM - Wednesday, April 27, 2016 11:59 PM
Total split fails for the selected period = 93

<table>
<thead>
<tr>
<th>Plan 0</th>
<th>Plan 1</th>
<th>Plan 10</th>
<th>Plan 13</th>
<th>Plan 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 SF</td>
<td>0 SF</td>
<td>26 SF</td>
<td>58 SF</td>
<td>9 SF</td>
</tr>
<tr>
<td>0% SF</td>
<td>0% SF</td>
<td>12% SF</td>
<td>64% SF</td>
<td>5% SF</td>
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</tbody>
</table>

Occupancy (%)

Time of Day

GOR - GapOut  GOR - ForceOff  ROR - GapOut  ROR - ForceOff  Avg. ROR  Avg. GOR  SplitFail
Phase 4 Extension Timer

Extension Timer = 3.0 seconds

\[
\begin{array}{ccc}
\Phi_1 & \Phi_2 & \Phi_3 \\
\Phi_5 & \Phi_6 & \Phi_7 \\
\Phi_8 & & \\
\end{array}
\]
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

Start of Green (12:52:21.1)

- Detector 6 On
- Detector 6 Off
- Detector 9 On
- Detector 9 Off
- Detector (6 or 9) On
- Detector (6 and 9) Off
- Occupancy Ratios
- Phase 4

Calculation Illustration of GOR and ROR$_5$
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

Detector 9 On
Detector 6 On
Detector (6 or 9) On
Detector (6 and 9) Off
Detector 6 Off
Detector 9 Off

Occupancy Ratios
Phase 4

Calculation Illustration of GOR and ROR$_5$
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

Detector 6
Detector 9

Detector 6 On
Detector 6 Off
Detector 9 On
Detector 9 Off
Detector (6 or 9) On
Detector (6 and 9) Off

Calculation Illustration of GOR and ROR$_5$

Phase 4

Occupancy Ratios
ROR₅ vs. GOR for an Oversaturated Split (Phase 4)

Detector 9
Detector 6
Detector 6 On
Detector 6 Off
Detector 9 On
Detector 9 Off
Detector (6 or 9) On
Detector (6 and 9) Off
Occupancy Ratios
Phase 4

Calculation Illustration of GOR and ROR₅
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

Calculation Illustration of GOR and ROR$_5$
ROR_5 vs. GOR for an Oversaturated Split (Phase 4)

Calculation Illustration of GOR and ROR_5

Detector 6 On
Detector 6 Off
Detector 9 On
Detector 9 Off
Detector (6 or 9) On
Detector (6 and 9) Off
Occupancy Ratios
Phase 4

ROR₅ vs. GOR for an Oversaturated Split (Phase 4)

Detector 9
Detector 6
Detector 6 On
Detector 6 Off
Detector 9 On
Detector 9 Off
Detector (6 or 9) On
Detector (6 and 9) Off
Occupancy Ratios
Phase 4

Calculation Illustration of GOR and ROR₅
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

Detector 9

Detector 6

Detector 6 On

Detector 6 Off

Detector (6 or 9) On

Detector (6 and 9) Off

Occupancy Ratios

Phase 4
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

Detector 9

Detector 6

Occupancy Ratios

Phase 4

Calculation Illustration of GOR and ROR$_5$
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

Detector 9
Detector 6
Detector 6 On
Detector 6 Off
Detector 9 On
Detector 9 Off
Detector (6 or 9) On
Detector (6 and 9) Off
Occupancy Ratios
Phase 4

Calculation Illustration of GOR and ROR$_5$
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

Detector 6 On
Detector 6 Off
Detector 9 On
Detector 9 Off
Detector (6 or 9) On
Detector (6 and 9) Off
Occupancy Ratios
Phase 4

Calculation Illustration of GOR and ROR$_5$
ROR₅ vs. GOR for an Oversaturated Split (Phase 4)

Detector 9 On
Detector 9 Off
Detector (6 or 9) On
Detector (6 and 9) Off

Occupancy Ratios
Phase 4

Calculation Illustration of GOR and ROR₅
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

Calculation Illustration of GOR and ROR$_5$
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

Detector 9

Detector 6

Detector 6 On

Detector 6 Off

Detector 9 On

Detector 9 Off

Detector (6 or 9) On

Detector (6 and 9) Off

Occupancy Ratios

Phase 4

Calculation Illustration of GOR and ROR$_5$
ROR₅ vs. GOR for an Oversaturated Split (Phase 4)

Calculation Illustration of GOR and ROR₅
ROR_5 vs. GOR for an Oversaturated Split (Phase 4)

Calculation Illustration of GOR and ROR_5
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

Detector 9
Detector 6
Detector 6 On
Detector 6 Off
Detector 9 On
Detector 9 Off
Detector (6 or 9) On
Detector (6 and 9) Off
Occupancy Ratios
Phase 4

Calculation Illustration of GOR and ROR$_5$
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

Detector 9
Detector 6
Detector 6 On
Detector 6 Off
Detector 9 On
Detector 9 Off
Detector (6 or 9) On
Detector (6 and 9) Off
Occupancy Ratios
Phase 4

Calculation Illustration of GOR and ROR$_5$
ROR$5$ vs. GOR for an Oversaturated Split (Phase 4)

Calculation Illustration of GOR and ROR$5$
**ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)**

![Diagram of traffic flow with detectors labeled](image)

**Occupancy Ratios**

- **Phase 4**
- **Detector 6 On**
- **Detector 6 Off**
- **Detector 9 On**
- **Detector 9 Off**
- **Detector (6 or 9) On**
- **Detector (6 and 9) Off**

**Calculation Illustration of GOR and ROR$_5$**

- Time: 12:52:00 to 12:53:00
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

Start of Red (12:52:44.1)

Calculation Illustration of GOR and ROR$_5$
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

**Detector 9**

**Detector 6**

**Phase 4**

**Occupancy Ratios**

**Calculation Illustration of GOR and ROR$_5$**
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

Detector 9

Detector 6

Detector 6 On

Detector 6 Off

Detector 9 On

Detector 9 Off

Detector (6 or 9) On

Detector (6 and 9) Off

Occupancy Ratios

Phase 4

Calculation Illustration of GOR and ROR$_5$
ROR₅ vs. GOR for an Oversaturated Split (Phase 4)

Detector 6
Detector 6 On
Detector 6 Off
Detector 9
Detector 9 On
Detector 9 Off
Detector (6 or 9) On
Detector (6 and 9) Off
Occupancy Ratios
Phase 4

Calculation Illustration of GOR and ROR₅
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

Calculation Illustration of GOR and ROR$_5$
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)

Detector 9

Detector 6

Detector 6 On

Detector 6 Off

Detector 9 On

Detector 9 Off

Detector (6 or 9) On

Detector (6 and 9) Off

Occupancy Ratios

Phase 4

5 Seconds After Start of Red (12:52:49.1)

Calculation Illustration of GOR and ROR$_5$
ROR₅ vs. GOR for an Oversaturated Split (Phase 4)
ROR$_5$ vs. GOR for an Oversaturated Split (Phase 4)
ROR₅ vs. GOR Plot for an Oversaturated Thru Movement
ROR$_5$ vs. GOR and/or V/C Ratio Summary (0900-1500)

Phase 1 ROR$_5$ vs. GOR

Phase 2 ROR$_5$ vs. GOR

Phase 3 ROR$_5$ vs. GOR

Phase 4 ROR$_5$ vs. GOR

Phase 5 ROR$_5$ vs. GOR

Phase 6 ROR$_5$ vs. GOR

Phase 7 ROR$_5$ vs. GOR

Phase 8 ROR$_5$ vs. GOR

Phase 2 V/C Ratio

Phase 6 V/C Ratio

Avg. v/c = 40.5%

Avg. v/c = 43.1%
ROR₅ vs. GOR and/or V/C Ratio Summary (0900-1500)

Phase 1 ROR₅ vs. GOR

Phase 2 ROR₅ vs. GOR

Phase 3 ROR₅ vs. GOR

Phase 4 ROR₅ vs. GOR

Phase 5 ROR₅ vs. GOR

Phase 6 ROR₅ vs. GOR

Phase 7 ROR₅ vs. GOR

Phase 8 ROR₅ vs. GOR

V/C Ratio

Avg. v/c = 40.5%

Avg. v/c = 43.1%

= Force offs
= Gap outs

9:00 10:00 11:00 12:00 13:00 14:00 15:00
Split Time Adjustment (0900-1500)

**Before**

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<td>$\Phi_2$</td>
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<tr>
<td>$\Phi_3$</td>
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<td>$\Phi_4$</td>
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<td>$\Phi_5$</td>
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<td>42%</td>
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<td>$\Phi_6$</td>
<td></td>
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<tr>
<td>$\Phi_7$</td>
<td>16%</td>
<td>20%</td>
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<tr>
<td>$\Phi_8$</td>
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**After**

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<td>11%</td>
<td>49%</td>
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<td>$\Phi_3$</td>
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<td>$\Phi_4$</td>
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<td>38%</td>
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<tr>
<td>$\Phi_7$</td>
<td>16%</td>
<td>24%</td>
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<td>$\Phi_8$</td>
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Phase 8 Before and After Comparison (0900-1500)

GOR vs. ROR_t5

= Force offs
= Gap outs

43 Oversaturated Splits

Before

ROR_t5 vs. GOR (Thurs. 7/18)
Phase 8 Before and After Comparison (0900-1500)

= Force offs
= Gap outs

15 Oversaturated Splits

ROR\textsubscript{5} vs. GOR (Thurs. 7/25)
Thursday Comparison

Bar Charts of Three Consecutive Split Failures (0900-1500)

**Undersaturated**

Avg. v/c before adjustment: 42.2%
Avg. v/c after adjustment: 44.3%

**Undersaturated**

Avg. v/c before adjustment: 44.4%
Avg. v/c after adjustment: 46.0%

= Before Split Adjustment (Thurs. 7/18)

= After Split Adjustment (Thurs. 7/25)
**Bar Charts of Three Consecutive Split Failures (0900-1500)**

**Friday Comparison**

**Undersaturated**
Avg. v/c before adjustment: 40.9%
Avg. v/c after adjustment: 44.8%

**Undersaturated**
Avg. v/c before adjustment: 45.6%
Avg. v/c after adjustment: 48.6%

- **Ф2**
  - Before Split Adjustment (Fri. 7/19)
  - After Split Adjustment (Fri. 7/26)

- **Ф4**
  - Before Split Adjustment (Fri. 7/19)
  - After Split Adjustment (Fri. 7/26)

- **Ф5**
  - Before Split Adjustment (Fri. 7/19)
  - After Split Adjustment (Fri. 7/26)

- **Ф6**
  - Before Split Adjustment (Fri. 7/19)
  - After Split Adjustment (Fri. 7/26)

- **Ф7**
  - Before Split Adjustment (Fri. 7/19)
  - After Split Adjustment (Fri. 7/26)

- **Ф8**
  - Before Split Adjustment (Fri. 7/19)
  - After Split Adjustment (Fri. 7/26)

- **Ф1**
  - Before Split Adjustment (Fri. 7/19)
  - After Split Adjustment (Fri. 7/26)

- **Ф3**
  - Before Split Adjustment (Fri. 7/19)
  - After Split Adjustment (Fri. 7/26)

- **Ф5**
  - Before Split Adjustment (Fri. 7/19)
  - After Split Adjustment (Fri. 7/26)

- **Ф6**
  - Before Split Adjustment (Fri. 7/19)
  - After Split Adjustment (Fri. 7/26)

- **Ф7**
  - Before Split Adjustment (Fri. 7/19)
  - After Split Adjustment (Fri. 7/26)

- **Ф8**
  - Before Split Adjustment (Fri. 7/19)
  - After Split Adjustment (Fri. 7/26)
Outcome Assessment of Peer-to-Peer Adaptive Control Adjacent
A view of the Arches entrance line. Cars are lined up onto US 191. (cw) #archesnps #archesnationalpark
SPLIT FAILURES AND SAFETY
Split Failures and Safety

https://youtu.be/59axuu-Qles
https://youtu.be/CH1oP05CBpY
Red Light Running

Concept developed by Lavrenz et. al.

Published in TRR

Goal is to make this tool accessible to agencies by including in specs for performance measures.
Red Light Running

End of Green Interval

Yellow Interval

Start of Red Interval

Det On

Det Off

Vehicle Arrival

Vehicle Departure

$\text{t}_{\text{arr}}$

$\text{t}_{\text{on}}$

Det On

Det Off

No

Yes
NB Stop Bar Detector
NB Stop Bar Detector
NB Stop Bar Detector
CR17 at SR120 2016-08-08 12:33:12
8/8/2016 12:33:11 PM

NB Stop Bar Detector
NB Stop Bar Detector
NB Stop Bar Detector

CR17 at SR120 2016-06-08 12:33:14

8/8/2016 12:33:13 PM
NB Stop Bar Detector
NB Stop Bar Detector
NB Stop Bar Detector
https://youtu.be/59axuu-Q1es
Evening Crash

https://youtu.be/CH1oP05CBpY
Case Study: US31 & 126th St. Split Adjustment

- Side street green split increased due to recurrent split failures
Cross Street is Green

Waiting Motorcycl
Case Study: US31 & 126th St. Split Adjustment

- Side street green split increased due to recurrent split failures

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<tr>
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<th>20% Split</th>
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<td>Mean RLR</td>
<td>6.968</td>
<td>4.579</td>
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<tr>
<td>Variance</td>
<td>15.081</td>
<td>5.656</td>
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<tr>
<td>Obs</td>
<td>62</td>
<td>38</td>
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<td>df</td>
<td>98</td>
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<td>t_critical</td>
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<td>1.660</td>
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Statistically significant decrease in RLR
Critical Performance Measures for Managing Signals

1. Is my communication working?
2. Are my detectors working?
3. Do I have adequate green time on each phase?
4. Do I have most of my vehicles arriving on green?

Write this Down if you agree!
Signal Performance Measures

Active Traffic & Pooled Fund Study

EDC-4 Initiative

PERFORMANCE MEASURES FOR TRAFFIC SIGNAL SYSTEMS
An Outcome-Oriented Approach

INTEGRATING TRAFFIC SIGNAL PERFORMANCE MEASURES INTO AGENCY BUSINESS PROCESSES

Automated Traffic Signal Performance Measures (ATSPMs)

Highway agencies typically rely on complaints or manual data collection processes to identify the need for and outcomes of signal retime projects. These projects are typically scheduled on a three- to five-year cycle, at a cost of approximately $4,500 per intersection. The costs and level of effort associated with collection of performance data translates into congestion, reduced safety and increased delays for vehicles, pedestrians and bicycles.

ATSPMs will revolutionize the management of traffic signals by providing the high resolution data necessary to actively manage performance. High quality service can be delivered to customers with significant cost savings to agency maintenance and operations activities. A number of technology implementation options are available including a low-cost open source code framework supported by peers, to fully integrated traffic signal system alternatives provided by vendors or consultants.
## Study Detail View

Enhanced Traffic Signal Performance Measures

### General Information

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### Contact Information:

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