Approach to Measure of Effectiveness

Shahram Malek, PhD, PE
Regional Traffic Operations Project Manager
RTOP

• Regional Traffic Operations Program

• Regionally significant traffic signal corridors in Atlanta

• 2010: 430 signals

• 2016: Over 1,100 signals
RTOP Teams Supporting GDOT

RTOP 1 (600+ signals)

Chester Thomas, PE PTOE
RTOP GDOT Manager
ChThomas@dot.ga.gov
404.635.2851

RTOP 2 (500+ signals)
Regionally Significant Corridors

I-285 (“The Perimeter”) shown with a black line
RTOP Goals

• Address Traffic Signal Maintenance and Repair Issues
• Regional Focus
  – Priority to Mainline
  – Cross-Jurisdictional Issues
• Actively Manage Traffic Flow
  Traffic Engineer
  Local Agencies
  Timing Contracts
  Traffic Engineer
  Loop Contractors
  Local Agencies
  Traffic Engineer

Preventative Maintenance
Signal Maintenance Contractor
Loop Contractors
1
2

LED Display Upgrades
ATC Contractor
GDOT Count Data

ITS Projects
STC 1
STC 2
STC 3
STC 4
STC 5
STC 6

Count Data
Loop Contractor

STC 1
STC 2
STC 3
STC 4
STC 5
STC 6
RTOP Mission: To increase travel reliability by minimizing congestion and reducing delays along regional commuter corridors through improved signal signal operations.
Firsts

- Shared Communication Network – RNET
- Program Based Technology Evaluation
- Cloud Based Traffic Signal System – Citrix
- Successful TR operation in GA – Across Jurisdiction Boundaries
- Video Sharing Architecture
- Ethernet over Copper
- Wireless Ethernet
- IP-based CCTV
- Retroreflective Backplates
- Deployments of Flashing Yellow Arrow
- Deployment of regional travel time detection system
RTOP Primary Tasks

• Active corridor management (incidents)

• Traffic signal timings

• Traffic signal maintenance

• Traffic signal infrastructure
RTOP Goals

- Address Traffic Signal Maintenance and Repair Issues
- Regional Focus – Priority to Mainline – Cross-Jurisdictional Issues
- Actively Manage Traffic Flow

RTOP Staff

- GDOT management
- Corridor managers
- Traffic signal technicians
- TMC operators
- Traffic signal contractors
Traffic Signal Operation Changes

- Address Traffic Signal Maintenance and Repair Issues
- Regional Focus
  - Priority to Mainline
  - Cross-Jurisdictional Issues
- Actively Manage Traffic Flow

# of RTOP Signals

<table>
<thead>
<tr>
<th>Year</th>
<th>Running Free</th>
<th>Uncoordinated</th>
<th>Time-of-Day Plans</th>
<th>Traffic Response</th>
<th>Adaptive</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016 (Current)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Communication

<table>
<thead>
<tr>
<th>Year</th>
<th>No Comm</th>
<th>Cell Modem</th>
<th>Wireless</th>
<th>Fiber Optic</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016 (Current)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CCTV

<table>
<thead>
<tr>
<th>Year</th>
<th>CCTV</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td></td>
</tr>
<tr>
<td>2016 (Current)</td>
<td></td>
</tr>
</tbody>
</table>
Performance Measure: Now & Future

• Performance influences

• Initial performance measures (2010)

• Current performance measures

• Future performance measures
Performance Influences

- Economic changes
- Road construction impacts
- Road/intersection improvements
- Shifting traffic patterns
- Price of fuel
Initial Performance Measures (2010)

• Detection performance

• Travel time runs

• Traffic volumes

• Time & fuel benefit

• Malfunction identification source
Vehicle & Pedestrian Detection Performance

Program Goal 95%

RTOP 1 Results
Travel Time Runs

**Stops**

**Delay**

**RTOP Goals**
- Address Traffic Signal Maintenance and Repair Issues
- Regional Focus
  - Priority to Mainline
  - Cross-Jurisdictional Issues
- Actively Manage Traffic Flow
  - Travel Time Runs
  - Stops
  - Delay

**Historical Trends for SR 141 (Johns Creek) NB**

- New Signal Timing Jan 14 – 25 (travel time)
- December 1-18 Timing (travel time)
- Nov 2-16 Timing (travel time)
- Speed Limit (travel time)
RTOP Goals

- Address Traffic Signal Maintenance and Repair Issues
- Regional Focus
  - Priority to Mainline
  - Cross-Jurisdictional Issues
- Actively Manage Traffic Flow

Traffic Volumes

Vehicle Miles Traveled Increase

Travel Time Increase

Percent Change


RTOP 1 Results
RTOP Goals

- Address Traffic Signal Maintenance and Repair Issues
- Regional Focus
  - Priority to Mainline
  - Cross-Jurisdictional Issues
- Actively Manage Traffic Flow

Time & Fuel Benefit

<table>
<thead>
<tr>
<th>Year</th>
<th>Time &amp; Fuel Benefit (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring 2011</td>
<td>$9.20</td>
</tr>
<tr>
<td>Fall 2011</td>
<td>$5.24</td>
</tr>
<tr>
<td>Spring 2012</td>
<td>$9.04 $8.93 $9.88</td>
</tr>
<tr>
<td>Fall 2012</td>
<td>$16.96 $18.15 $16.98</td>
</tr>
<tr>
<td>Spring 2013</td>
<td>$16.98</td>
</tr>
<tr>
<td>Fall 2013</td>
<td></td>
</tr>
<tr>
<td>Spring 2014</td>
<td></td>
</tr>
<tr>
<td>Fall 2014</td>
<td></td>
</tr>
<tr>
<td>Spring 2015</td>
<td>$14.71</td>
</tr>
</tbody>
</table>

RTOP 1 Results
### Malfunction Identification Source

#### PROACTIVE IDENTIFICATION OF EVENTS

<table>
<thead>
<tr>
<th>Actively Managed Corridors</th>
<th>Percentage (%)</th>
<th>Total Reported by Local Agency</th>
<th>Total Found by CM</th>
<th>Actively Managed Corridors</th>
<th>Percentage (%)</th>
<th>Total Reported by Local Agency</th>
<th>Total Found by CM</th>
<th>Actively Managed Corridors</th>
<th>Percentage (%)</th>
<th>Total Reported by Local Agency</th>
<th>Total Found by CM</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR 3 - Cobb/Naide</td>
<td>Oct 2015</td>
<td>93.5%</td>
<td>4</td>
<td>91.5%</td>
<td>Oct 2015</td>
<td>91.5%</td>
<td>10</td>
<td>96.4%</td>
<td>Nov 2015</td>
<td>2</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Nov 2015</td>
<td>91.0%</td>
<td>6</td>
<td>87.9%</td>
<td>Nov 2015</td>
<td>87.9%</td>
<td>8</td>
<td>97.3%</td>
<td>Dec 2015</td>
<td>2</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Dec 2015</td>
<td>76.7%</td>
<td>14</td>
<td>88.5%</td>
<td>Dec 2015</td>
<td>88.5%</td>
<td>12</td>
<td>89.0%</td>
<td>Nov 2015</td>
<td>9</td>
<td>73</td>
</tr>
<tr>
<td>SR 3 - Tara/Old Dixie</td>
<td>Oct 2015</td>
<td>95.7%</td>
<td>8</td>
<td>100.0%</td>
<td>Oct 2015</td>
<td>100.0%</td>
<td>0</td>
<td>89.9%</td>
<td>Dec 2015</td>
<td>0</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>Nov 2015</td>
<td>94.8%</td>
<td>5</td>
<td>100.0%</td>
<td>Nov 2015</td>
<td>100.0%</td>
<td>0</td>
<td>89.9%</td>
<td>Dec 2015</td>
<td>8</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>Dec 2015</td>
<td>98.9%</td>
<td>1</td>
<td>100.0%</td>
<td>Dec 2015</td>
<td>100.0%</td>
<td>0</td>
<td>100.0%</td>
<td>Nov 2015</td>
<td>1</td>
<td>42</td>
</tr>
<tr>
<td>SR 8 - Dekalb/Lville</td>
<td>Oct 2015</td>
<td>100.0%</td>
<td>0</td>
<td>100.0%</td>
<td>Oct 2015</td>
<td>100.0%</td>
<td>0</td>
<td>97.7%</td>
<td>Dec 2015</td>
<td>0</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>Nov 2015</td>
<td>99.6%</td>
<td>1</td>
<td>100.0%</td>
<td>Nov 2015</td>
<td>100.0%</td>
<td>0</td>
<td>100.0%</td>
<td>Dec 2015</td>
<td>0</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>Dec 2015</td>
<td>100.0%</td>
<td>0</td>
<td>100.0%</td>
<td>Dec 2015</td>
<td>100.0%</td>
<td>0</td>
<td>100.0%</td>
<td>Dec 2015</td>
<td>0</td>
<td>75</td>
</tr>
<tr>
<td>SR 8 - Fulton/PDL</td>
<td>Oct 2015</td>
<td>100.0%</td>
<td>15</td>
<td>71.4%</td>
<td>Oct 2015</td>
<td>71.4%</td>
<td>10</td>
<td>81.3%</td>
<td>Oct 2015</td>
<td>12</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>Nov 2015</td>
<td>100.0%</td>
<td>28</td>
<td>92.9%</td>
<td>Nov 2015</td>
<td>92.9%</td>
<td>6</td>
<td>81.3%</td>
<td>Nov 2015</td>
<td>14</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Dec 2015</td>
<td>100.0%</td>
<td>10</td>
<td>86.6%</td>
<td>Dec 2015</td>
<td>86.6%</td>
<td>17</td>
<td>95.1%</td>
<td>Dec 2015</td>
<td>5</td>
<td>98</td>
</tr>
<tr>
<td>SR 9 - Buckhead</td>
<td>Oct 2015</td>
<td>100.0%</td>
<td>7</td>
<td>93.8%</td>
<td>Nov 2015</td>
<td>93.8%</td>
<td>3</td>
<td>100.0%</td>
<td>Oct 2015</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Nov 2015</td>
<td>100.0%</td>
<td>44</td>
<td>68.8%</td>
<td>Dec 2015</td>
<td>68.8%</td>
<td>5</td>
<td>100.0%</td>
<td>Nov 2015</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Dec 2015</td>
<td>99.1%</td>
<td>4</td>
<td>430</td>
<td>Dec 2015</td>
<td>98.4%</td>
<td>10</td>
<td>600</td>
<td>Dec 2015</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The RTOP team is actively monitoring every corridor in order to identify and resolve malfunctioning equipment and signal timing issues. The Proactive Identification of Events table compares the number of malfunctions, roadway incidents, and operational issues reported by local agencies versus the RTOP team. The RTOP goal is to have 70.0% of events reported by the RTOP team.
Current Performance Measures

- Travel time system
- Traffic signal asset tracking
- Automated monthly report spreadsheet
Travel Time System

Devices - Georgia DOT

Map data ©2016 Google 20 km L

Sensys Networks
BlueTOAD
Acyclica
Wavetronix

Georgia Department of Transportation

Arcadis
RTOP Goals

• Address Traffic Signal Maintenance and Repair
• Regional Focus
  – Priority to Mainline
  – Cross-Jurisdictional Issues
• Actively Manage Traffic Flow

Major Incident Example

- **Date:** 02/10/2016
- **Location:** N Druid Hills Road
- **Direction:** Southbound
- **Incident Clear Time:** Approx. 30 mins.

7:55 AM: TSOS found accident on DEK-CAM-011 and reported to CM & DeKalb county through TEAMS (Intersection is controlled by DeKalb county, not RTOP)

8:04 AM: Fire, EMS, & wrecker on scene blocking one SB Lanes

8:07 AM: TSOS report accident to 511

8:31 AM: Wrecker leaves scene; all lanes open
Travel Times

- Time periods of interest
  - Morning peak period: 4 hours (6 – 10 AM)
  - Mid-day: 5 hours (10 AM – 3 PM)
  - Afternoon peak period: 4 hours (3 – 7 PM)

- Reliability

  Travel Time Index (TTI)

  Buffer Time Index (BTI)

  Free Flow Conditions = 1

  No variation = 0
Traffic Signal Asset Tracking

- Asset Management
- Malfunctions
- Incidents
- Operational
- Preventative Maintenance
- Reporting
- Accident Management
## Automated Monthly Report

### Traffic Signal Task Status

<table>
<thead>
<tr>
<th>Task Type</th>
<th>Oct-15</th>
<th>Nov-15</th>
<th>Dec-15</th>
<th>Jan-16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malfunctions</td>
<td>20</td>
<td>8</td>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>Incidents</td>
<td>18</td>
<td>6</td>
<td>13</td>
<td>21</td>
</tr>
<tr>
<td>Operations</td>
<td>14</td>
<td>9</td>
<td>13</td>
<td>29</td>
</tr>
<tr>
<td>Preventative Maintenance</td>
<td>9</td>
<td>46</td>
<td>21</td>
<td>16</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Total - Created Tasks: 62
Total - Resolved Tasks: 50

### Device Status

<table>
<thead>
<tr>
<th>Device Status</th>
<th>Nov-15</th>
<th>Dec-15</th>
<th>Jan-16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Detection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational</td>
<td>724</td>
<td>724</td>
<td>724</td>
</tr>
<tr>
<td>Total</td>
<td>726</td>
<td>726</td>
<td>726</td>
</tr>
<tr>
<td>% Operational</td>
<td>99.7%</td>
<td>99.7%</td>
<td>99.7%</td>
</tr>
<tr>
<td>Pedestrian Detection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational</td>
<td>394</td>
<td>394</td>
<td>394</td>
</tr>
<tr>
<td>Total</td>
<td>399</td>
<td>399</td>
<td>399</td>
</tr>
<tr>
<td>% Operational</td>
<td>98.7%</td>
<td>98.7%</td>
<td>98.7%</td>
</tr>
<tr>
<td>Traffic Cameras (CCTV)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational</td>
<td>40</td>
<td>40</td>
<td>41</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>% Operational</td>
<td>93.0%</td>
<td>93.0%</td>
<td>95.3%</td>
</tr>
<tr>
<td>Travel Time Detector (TTD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational</td>
<td>31</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>% Operational</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
Automated Monthly Report

### Average Vehicle Throughput

<table>
<thead>
<tr>
<th>AM Peak (6-10 AM, 4 hours)</th>
<th>Mid-Day (10 AM - 3 PM, 5 hours)</th>
<th>PM Peak (3-7 PM, 4 hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9,000</td>
<td>9,000</td>
<td>9,000</td>
</tr>
<tr>
<td>Jan-16</td>
<td>Jan-16</td>
<td>Jan-16</td>
</tr>
<tr>
<td>8,500</td>
<td>8,500</td>
<td>8,500</td>
</tr>
<tr>
<td>Dec-15</td>
<td>Dec-15</td>
<td>Dec-15</td>
</tr>
<tr>
<td>8,000</td>
<td>8,000</td>
<td>8,000</td>
</tr>
<tr>
<td>Nov-15</td>
<td>Nov-15</td>
<td>Nov-15</td>
</tr>
<tr>
<td>7,500</td>
<td>7,500</td>
<td>7,500</td>
</tr>
</tbody>
</table>

Note: The baseline month-year shown (in bold below) provides a reference point for traffic volume comparison.

<table>
<thead>
<tr>
<th>AM Peak</th>
<th>Throughput</th>
<th>% Change</th>
<th>Mid-Day</th>
<th>Throughput</th>
<th>% Change</th>
<th>PM Peak</th>
<th>Throughput</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-16</td>
<td>7,503</td>
<td>1.0%</td>
<td>Jan-16</td>
<td>10,322</td>
<td>-5.5%</td>
<td>Jan-16</td>
<td>10,223</td>
<td>-5.5%</td>
</tr>
<tr>
<td>Dec-15</td>
<td>7,645</td>
<td>2.9%</td>
<td>Dec-15</td>
<td>10,842</td>
<td>-0.7%</td>
<td>Dec-15</td>
<td>10,546</td>
<td>-2.5%</td>
</tr>
<tr>
<td>Nov-15</td>
<td>7,541</td>
<td>1.5%</td>
<td>Nov-15</td>
<td>10,722</td>
<td>-1.8%</td>
<td>Nov-15</td>
<td>10,360</td>
<td>-4.2%</td>
</tr>
</tbody>
</table>

Note: The throughput is based on actual traffic counts at multiple locations, and weighted by predetermined corridor segment lengths.

### Corridor Assets

<table>
<thead>
<tr>
<th>Assets</th>
<th>Start of Year</th>
<th>Changed This Year</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total signals under management</td>
<td>96</td>
<td>0</td>
<td>96</td>
</tr>
<tr>
<td>Traffic signal operation</td>
<td>96</td>
<td>0</td>
<td>96</td>
</tr>
<tr>
<td>Running free/uncoordinated</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Time-of-Day Control</td>
<td>14</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td>Traffic Responsive Operation</td>
<td>38</td>
<td>0</td>
<td>38</td>
</tr>
<tr>
<td>Adaptive Control</td>
<td>43</td>
<td>0</td>
<td>43</td>
</tr>
<tr>
<td>Other control method</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Traffic Camera Locations</td>
<td>43</td>
<td>0</td>
<td>43</td>
</tr>
<tr>
<td>Travel Time Detector Locations</td>
<td>31</td>
<td>0</td>
<td>31</td>
</tr>
<tr>
<td>Flashing Yellow Arrow conversions</td>
<td>12</td>
<td>0</td>
<td>12</td>
</tr>
</tbody>
</table>

### 24-hour Volumes at: Galleria Pkwy (Cumberland)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Automated Monthly Report

Event Details - Historical Characteristics

Source
- 511 Operator: 29%
- RTOP program: 71%

Time Period
- AM Peak: 43%
- Mid-day: 35%
- PM Peak: 22%

On Corridor?
- Off: 79%
- On: 21%

Type
- Crash: 81%
- Major debris/obstacle: 6%
- Minor debris/obstacle: 2%
- Other: 1%
- Pavement failure: 1%
- Unusual congestion: 9%

Response/Action
- Flush plan: 17%
- Monitor only: 7%
- Pattern change: 1%
- Police traffic control: 75%

Events are circumstances that affect the RTOP corridor road capacity and/or volumes, which include the possibility that an intervention by the Corridor Manager may be required. Some events only require monitoring (observations over time), and some events require temporary changes to the traffic signal software to improve throughput during the event.

Event Details - Current Month

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Source</th>
<th>Event on corridor?</th>
<th>Specific Location</th>
<th>Period</th>
<th>Event Type</th>
<th>Response/Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4/2016</td>
<td>511 Operator</td>
<td>Off</td>
<td>I-285 NB @ Cobb Pkwy</td>
<td>PM Peak</td>
<td>Crash</td>
<td>Monitor only</td>
</tr>
<tr>
<td>1/5/2016</td>
<td>511 Operator</td>
<td>Off</td>
<td>I-75 @ I-575</td>
<td>AM Peak</td>
<td>Major debris/obstacle</td>
<td>Monitor only</td>
</tr>
<tr>
<td>1/5/2016</td>
<td>511 Operator</td>
<td>Off</td>
<td>I-575 @ Barret Pkwy</td>
<td>PM Peak</td>
<td>Crash</td>
<td>Monitor only</td>
</tr>
<tr>
<td>1/7/2016</td>
<td>RTOP program</td>
<td>On</td>
<td>SR3 @ Greers Chapel</td>
<td>PM Peak</td>
<td>Crash</td>
<td>Monitor only</td>
</tr>
<tr>
<td>1/11/2016</td>
<td>511 Operator</td>
<td>Off</td>
<td>I-75 SB @ Delk</td>
<td>PM Peak</td>
<td>Crash</td>
<td>Monitor only</td>
</tr>
<tr>
<td>1/12/2016</td>
<td>511 Operator</td>
<td>Off</td>
<td>I-75 NB @ NMP</td>
<td>PM Peak</td>
<td>Minor debris/obstacle</td>
<td>Monitor only</td>
</tr>
<tr>
<td>1/13/2016</td>
<td>511 Operator</td>
<td>Off</td>
<td>I-75 SB @ Cumberland</td>
<td>AM Peak</td>
<td>Crash</td>
<td>Monitor only</td>
</tr>
</tbody>
</table>
Future Performance Measures

- High definition data
- Real-time dashboard
- Improved benefit calculations
Benefit Calculation Opportunities

• 24/7/365 travel time and fuel
• Freeway incident-related benefits
• Safety
• Return on investment on equipment up-time
• Economic growth
Benefits Technical Challenges

• Defining the no-build baseline metrics

• Tracking safety benefits

• Calculating regional impact
Questions?

Shahram Malek, PhD, PE
ARCADIS U.S. Inc.
RTOP Project Manager
Shahram.Malek@arcadis-us.com