ATSPM in the City of Dublin, CA

What Agencies Can Accomplish
Automated Traffic Signal Performance Measures (ATSPM)

- Over 330,000 traffic signals are currently operating in the U.S.
- Largely reliant on citizen complaints and manual signal timing design methods – timing consuming and expensive
- FHWA’s fourth round of Every Day Counts (EDC-4) innovation “automated traffic signal performance measures” (ATSPM)
  - An evolution in signal management
  - Provide continuous monitoring of more than a dozen performance measures based on high-resolution event-based data
  - Linear reactive method -> Method of operation that continuously use data to provide feedback
City of Dublin

- ITS-based strategies on a 3.6-mile stretch of Dublin Boulevard
  - Adaptive Traffic Control System
  - Bus Queue Jump
  - Transit Signal Priority
  - Bicycle Detection System

- History
  - City purchased ATMS with ATSPM features
  - City installed Cloud-based ATSPM Module
Outline

• Reasonable Check of Each Performance Measure

• Case Studies
  ◦ Performance Measures Used for ATSPM-Based Before-After Study for Dublin Blvd ATCS
  ◦ Queuing on WB Dublin Blvd
  ◦ WBL improvement on Dublin/Village Intersection

• Top Performance Measures to Use
Reasonable Check of Each Performance Measure
Coding Issue – Before
Coding Issue – After
ATMS Software Issue - Before
ATMS Software Issue - After

Purdue Phase Termination Diagram

Time: 05/23/2018 12:00:00
05/23/2018 11:59:59

Controller: 8 Dublin Blvd @ Amador Plaza

Split History with Max(M), Gap(G), and Force-off(F)

Report Date: 5/28/2018

Controller: 8 Dublin Blvd @ Amador Plaza

Date/Time Pattern Cycle SP1 SP2 SP3 SP4 SP5 SP6 SP7 SP8 SP9 SP10 SP11 SP12 SP13 SP14 SP15 SP16
05/23/2018 00:01:19 AM 254 17 0 17/G 0 0 0 17/G 0 0 0 0 0 0 0 0 0 0
05/23/2018 00:01:36 AM 254 251 24/G 216/G 11/G 0 0 23/G 217/G 0 11/G 0 0 0 0 0 0 0
05/23/2018 00:05:47 AM 254 255 13/G 242/G 0 0 0 11/G 242/G 0 10/G 0 0 0 0 0 0 0 0
05/23/2018 00:10:02 AM 254 45 0 36/G 0 0 0 11/G 242/G 0 10/G 0 0 0 0 0 0 0 0
05/23/2018 00:10:47 AM 254 28 0 17/G 0 11/G 0 17/G 0 0 0 0 0 0 0 0 0 0 0
05/23/2018 00:11:15 AM 254 255 14/G 241/G 0 0 0 10/G 245/G 0 0 0 0 0 0 0 0 0 0
05/23/2018 00:15:30 AM 254 229 19/G 211/G 0 0 0 21/G 208/G 0 0 0 0 0 0 0 0 0 0
05/23/2018 00:19:19 AM 254 158 0 147/G 0 0 0 147/G 0 11/G 0 0 0 0 0 0 0 0 0
05/23/2018 00:21:57 AM 254 128 11/G 98/G 9/G 0 0 109/G 0 10/G 0 0 0 0 0 0 0 0 0
05/23/2018 00:24:05 AM 254 255 12/G 231/G 1 0 0 243/G 0 11/G 0 0 0 0 0 0 0 0 0
05/23/2018 00:28:20 AM 254 8 0 0 8/G 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
05/23/2018 00:28:20 AM 254 8 0 0 8/G 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
05/23/2018 00:28:20 AM 254 58 0 47/G 0 0 0 47/G 0 11/G 0 0 0 0 0 0 0 0 0
05/23/2018 00:29:26 AM 254 64 12/G 42/G 0 0 0 54/G 0 10/G 0 0 0 0 0 0 0 0 0
05/23/2018 00:30:30 AM 254 127 14/G 93/G 9/G 0 0 107/G 0 11/G 0 0 0 0 0 0 0 0 0
05/23/2018 00:32:37 AM 254 231 0 220/G 0 0 0 220/G 11/G 0 0 0 0 0 0 0 0 0 0
05/23/2018 00:36:28 AM 254 186 11/G 165/G 0 0 11/G 164/G 0 11/G 0 0 0 0 0 0 0 0 0
<table>
<thead>
<tr>
<th>Cross Street</th>
<th>Turning Movement Volume Report</th>
<th>Arrival on Red Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Ramon</td>
<td>NBT 2 lanes (should be 3) EBT 3 lanes (should be 2) WBL 2 lanes (should be 3) WBL graphic problem</td>
<td>2 phase 4 graphics - 1 for EB 1 for NB</td>
</tr>
<tr>
<td>Regional</td>
<td></td>
<td>2 phase 8 graphics – 1 for NB and 1 for EB</td>
</tr>
<tr>
<td>Golden Gate</td>
<td>EBR graphic shown (No exclusive EBR)</td>
<td></td>
</tr>
<tr>
<td>Amador Plaza</td>
<td>EBR graphic shown (No exclusive EBR) No WBR graphic</td>
<td></td>
</tr>
<tr>
<td>Village</td>
<td>NBT 1 lanes (should be 2) SBT 2 lanes (should be 1)</td>
<td>2 phase 8 graphics – 1 for NB and 1 for SB</td>
</tr>
<tr>
<td>Clark</td>
<td>No NBL graphic EBL graphic problem</td>
<td></td>
</tr>
<tr>
<td>Sierra-Civic</td>
<td>SBT graphic problem</td>
<td>No graphic for phase 3/4/7/8</td>
</tr>
<tr>
<td>Dublin Court</td>
<td>WBT 2 lanes (should be 3)</td>
<td>No graphic for phase 4/7</td>
</tr>
<tr>
<td>Dougherty</td>
<td></td>
<td>2 phase 8 graphics – 1 for EB 1 for NB</td>
</tr>
<tr>
<td>Scarlett</td>
<td></td>
<td></td>
</tr>
<tr>
<td>De Marcus</td>
<td>No NBL graphic EBL and EBT graphic problems WBT lane 2 missing in the graphic</td>
<td>Phase 3 graphic is for EB</td>
</tr>
<tr>
<td>Iron Horse</td>
<td>EBT graphic problem WBT lane 2 missing in the graphic</td>
<td></td>
</tr>
<tr>
<td>Arnold</td>
<td>NBL lane 1 missing in the graphic EBL and EBT graphic problems WBT lane 1 missing in the graphic</td>
<td>2 phase 3 graphics – 1 for NB 1 for EB Phase 7/8/4 graphic are all for SB</td>
</tr>
<tr>
<td>Persimmon</td>
<td>NBL 2 lane (should be 1 lane) No NBT graphic EBT graphic problem WBT lane 2 missing in the graphic</td>
<td></td>
</tr>
<tr>
<td>Hacienda</td>
<td></td>
<td>2 phase 2 graphics – 1 for EB 1 for NB</td>
</tr>
<tr>
<td>Hacienda/Martineili</td>
<td>NBT 2 lanes (should be 3) EBT 2 lanes (should be 1)</td>
<td>Phase 8 graphic is for EB</td>
</tr>
</tbody>
</table>
Cloud-Based ATSPM Report Graphics Issue
Case Studies
ATSPM-Based Before-After Study

- Vehicle Throughput
  - Intersection Turning Movement Volumes (Volume/Occupancy Per Lane Graph)
- Progression Quality on Coordinated Phases
  - Percent of Arrival on Green (Purdue Coordination Diagram, Arrivals on Red Report)
- Minor Street Efficiency
  - Percent of Cycle Length given to Side Street Green Phases (Purdue Coordination Diagram, Arrivals on Red Report)
  - Phase Termination Causes (Purdue Phase Termination Diagram, Split Monitor Report, Split History with Max/Gap/Force-Off Report)
  - Level of Service (Approach Delay)
- Pedestrian Delay (Pedestrian Delay Report)
- Activation of Bicycle Detection (Volume/Occupancy Report)
- Activation of Bus Queue Jump (Volume/Occupancy Report)
- Activation of Transit Priority (Transit Priority Report)
Volume/Occupancy Per Lane Graph - Vehicle Throughput

Volume Lane Graphic

Out 1156

In 470

Total 1626

Int Volume: 4523

Dublin Blvd @ Dougherty Rd
Intersection: 13

Report Time: 06/17/18
Time: 10/24/2017 07:00:00
To: 10/24/2017 07:59:59

TOTAL 2458

In 1539

Out 919

TOTAL 1967

IN 1020

OUT 947

TOTAL 3006

IN 579

Out 2417

TOTAL 1626

TOTAL 158

IN 81

Out 77

TOTAL 60

TOTAL 180

IN 72

Out 108

TOTAL 36

TOTAL 111

IN 29

Out 82

TOTAL 111

TOTAL 181

IN 50

Out 131

TOTAL 181

TOTAL 0

IN 0

Out 0

TOTAL 0

TOTAL 0

IN 0

Out 0

TOTAL 0

TOTAL 0

IN 0

Out 0

TOTAL 0

TOTAL 0

IN 0

Out 0

TOTAL 0

TOTAL 91

IN 51

Out 40

TOTAL 91

TOTAL 0

IN 0

Out 0

TOTAL 0

TOTAL 0

IN 0

Out 0

TOTAL 0

TOTAL 0

IN 0

Out 0

TOTAL 0

TOTAL 99

IN 51

Out 48

TOTAL 99
Purdue Coordination Diagram – Progression Quality on Coordination Phases
Arrival on Red – Progression Quality on Coordination Phases
Purdue Coordination Diagram – Side Street Efficiency
Arrival on Red – Side Street Efficiency
Approach Delay – Side Street Level of Service
### Split History

**Phase Termination Causes**

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Pattern</th>
<th>Cycle</th>
<th>SP1</th>
<th>SP2</th>
<th>SP3</th>
<th>SP4</th>
<th>SP5</th>
<th>SP6</th>
<th>SP7</th>
<th>SP8</th>
<th>SP9</th>
<th>SP10</th>
<th>SP11</th>
<th>SP12</th>
<th>SP13</th>
<th>SP14</th>
<th>SP15</th>
<th>SP16</th>
</tr>
</thead>
<tbody>
<tr>
<td>05/23/2018 07:00:12 AM</td>
<td>254</td>
<td>201</td>
<td>39/G</td>
<td>129/F</td>
<td>8/G</td>
<td>25/G</td>
<td>36/G</td>
<td>132/F</td>
<td>0</td>
<td>33/G</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>05/23/2018 07:03:33 AM</td>
<td>30</td>
<td>115</td>
<td>18/G</td>
<td>75/F</td>
<td>9/G</td>
<td>13/G</td>
<td>11/G</td>
<td>82/F</td>
<td>11/G</td>
<td>11/G</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>05/23/2018 07:05:28 AM</td>
<td>30</td>
<td>117</td>
<td>33/G</td>
<td>56/F</td>
<td>0</td>
<td>28/G</td>
<td>18/G</td>
<td>71/F</td>
<td>18/G</td>
<td>10/G</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>05/23/2018 07:07:25 AM</td>
<td>30</td>
<td>115</td>
<td>20/G</td>
<td>71/F</td>
<td>9/G</td>
<td>15/G</td>
<td>0</td>
<td>91/F</td>
<td>12/G</td>
<td>12/G</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>05/23/2018 07:09:20 AM</td>
<td>30</td>
<td>116</td>
<td>22/G</td>
<td>63/F</td>
<td>11/G</td>
<td>20/G</td>
<td>20/G</td>
<td>65/F</td>
<td>11/G</td>
<td>20/G</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>05/23/2018 07:11:15 AM</td>
<td>30</td>
<td>114</td>
<td>31/F</td>
<td>29/F</td>
<td>19/G</td>
<td>35/F</td>
<td>13/G</td>
<td>47/F</td>
<td>11/G</td>
<td>43/G</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>05/23/2018 07:13:10 AM</td>
<td>30</td>
<td>116</td>
<td>32/G</td>
<td>56/F</td>
<td>10/G</td>
<td>18/G</td>
<td>15/G</td>
<td>73/F</td>
<td>8/G</td>
<td>20/G</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>05/23/2018 07:15:06 AM</td>
<td>30</td>
<td>119</td>
<td>19/G</td>
<td>74/F</td>
<td>9/G</td>
<td>17/G</td>
<td>14/G</td>
<td>79/F</td>
<td>0</td>
<td>26/G</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>05/23/2018 07:17:05 AM</td>
<td>30</td>
<td>125</td>
<td>23/G</td>
<td>54/F</td>
<td>13/G</td>
<td>35/G</td>
<td>23/G</td>
<td>54/F</td>
<td>21/G</td>
<td>27/G</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>05/23/2018 07:19:10 AM</td>
<td>30</td>
<td>120</td>
<td>21/G</td>
<td>63/F</td>
<td>0</td>
<td>36/G</td>
<td>16/G</td>
<td>68/F</td>
<td>15/G</td>
<td>21/G</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>05/23/2018 07:21:10 AM</td>
<td>30</td>
<td>115</td>
<td>24/G</td>
<td>60/F</td>
<td>18/G</td>
<td>13/G</td>
<td>0</td>
<td>84/F</td>
<td>11/G</td>
<td>20/G</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>05/23/2018 07:23:05 AM</td>
<td>30</td>
<td>120</td>
<td>11/G</td>
<td>63/F</td>
<td>14/G</td>
<td>32/G</td>
<td>0</td>
<td>74/F</td>
<td>13/G</td>
<td>33/G</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>05/23/2018 07:25:05 AM</td>
<td>30</td>
<td>115</td>
<td>29/F</td>
<td>29/F</td>
<td>20/G</td>
<td>37/F</td>
<td>11/G</td>
<td>47/F</td>
<td>12/G</td>
<td>45/G</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>05/23/2018 07:27:00 AM</td>
<td>30</td>
<td>115</td>
<td>33/G</td>
<td>50/F</td>
<td>11/G</td>
<td>21/G</td>
<td>11/G</td>
<td>72/F</td>
<td>14/G</td>
<td>18/G</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Phase Termination Diagram
Split Monitor Report
Pedestrian Delay

Pedestrian Delay
Dublin Blvd Golden Gate Signal 00007
Wednesday, May 23, 2018 12:00 AM - Wednesday, May 23, 2018 11:59 PM
Phase 4

Summary
Pedestrian Activations = 258
Minimum Delay = 0.01
Maximum Delay = 22.10
Average Delay = 10.53

Pedestrian Delay
by Activation (seconds)
Case Study 2 – WB Traffic Stopped at Civic Plaza During the Morning Peak Period
Time-Space Diagram - Before
Time-Space Diagram – After
(Shift Offset @ Sierra-Civic by -20 seconds)
Case Study 3 –
Long LT Green without Gapping Out
Phase Termination Diagram - Before
Phase Termination Diagram – After
(Fixed the Detector Card Issue)
Split Monitor Report – After
(Fixed the Detector Card Issue)
Top Performance Measures for System Health Check-up and Operational Monitoring
1. System Health

- Any Purdue Report
- Phase Termination Diagram/Split Monitor Report
- Pedestrian Delay Report
- Volume/Occupancy per Lane Graph
2. Signal Coordination Operations

- Purdue Coordination Diagram
- Arrival on Red
- Time-Space Diagram
3. Left-Turn/Side-Street Green Too Short

- Split Monitor Report
- Split History Report with Max/Gap/Force Off
- Phase Termination Diagram
- Approach Delay Report
- Green Utilization Report (For Adaptive Intersections Only)
UDOT Metric Utilization Frequency

1. Time-Space Diagram
2. Split History Report
3. Green Utilization Report
References

• UDOT Automated Transportation Signal Performance Measures, UDOT

• Automated Transportation Signal Performance Measures, FHWA,

Questions?

Joanna Liu, PE
Joanna@amobility.com
Advanced Mobility Group
925.285.6788

Joy Bhattacharya, PE, PTOE
Joy@amobility.com
Advanced Mobility Group
415.688.0024