Transportation Data Potpourri in Frisco

TexITE Joint Dallas-Fort Worth Section Meeting
May 11, 2018

Curtis Jarecki, P.E.
Brian Moen, P.E.
City of Frisco
Overview

- Signal Performance Measures
- Signal Data Sharing
- Waze Traffic Data
- Closest To Dispatching
- Autonomous Vehicles
- What’s Next For Frisco?
Road Map for SPM

- Detection Requirements for SPM
- Detection Setup Examples
- Detection Standard
- Example – Occupancy on Green
- Example – Phase Termination
- Example – Crowd Travel Time
Detection Requirements

TYPICAL DETECTION REQUIREMENTS
Detection Requirements

<table>
<thead>
<tr>
<th>DETECTION REQUIREMENTS</th>
<th>ADVANCE DETECTOR</th>
<th>RED LIGHT MONITOR (RLM)</th>
<th>STOP BAR DETECTOR</th>
<th>TURNING MOVEMENT COUNT (TMC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPROACH DELAY</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>APPROACH VOLUME</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARRIVALS ON RED</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEDESTRIAN DELAY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PREEMPTION DETAILS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PURDUE COORDINATION DIAGRAM</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PURDUE PHASE TERMINATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PURDUE SPLIT FAILURE</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>SPLIT MONITOR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TURNING MOVEMENT COUNTS</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>YELLOW AND RED ACTUATIONS</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
Detector Requirements

- 11 Standard SPMs
- 4 of 11 with ATC controller
- 3 of 11 with most stop bar detection
- 4 of 11 with setback detection
Stop Bar Setup - Video
Stop Bar Setup - RADAR
Stop Bar - Magnetometers
Setback Setup - General

• Where to put the setback detection point(s)?

Some things to consider:
  – Performance Measures
  – Dilemma Zone Protection
  – Operational Efficiency
  – Adaptive Control Needs
Setback Setup - General

- Performance Measures
  - Ideal is farther back than the maximum queue length.

- Dilemma Zone Protection
  - 5.5 seconds away 90% stop
  - 2.5 seconds away 10% stop

- Operational Efficiency
  - ~2.5 seconds (varies with speed & zone size)

- Adaptive Control Needs
  - Works with what is best for other considerations
Setback Setup - General

- Performance Measures
- Dilemma Zone Protection
  - 5.5 seconds away 90% stop
  - 2.5 seconds away 10% stop
- Operational Efficiency
  - ~2.5 seconds (varies with speed & zone size)
- Adaptive Control Needs
Setback Setup - General

- Performance Measures – another detection point could be added
- Dilemma Zone Protection – 3 second extension (gap time)
  - 5.5 seconds away 90% stop
  - 2.5 seconds away 10% stop
- Operational Efficiency – about 2.5 second extension
- One has to choose between dilemma zone and operational efficiency
Setback Setup - RADAR
Setback - Magnetometers
Detection Standard

• Standard for
  – Standard Intersection
  – Diamond Intersection
  – Box Diamond Intersection

• Detector Inputs
  – Need 128 (8 BUls) detector inputs.
  – 64 (4 BUls) is not enough.
## Detection Standard

### Standard 8

<table>
<thead>
<tr>
<th>Pin</th>
<th>Label - Phase</th>
<th>Source</th>
<th>Func</th>
<th>BIU 9</th>
<th>Detector</th>
<th>Phase</th>
<th>Source</th>
<th>Func</th>
<th>BIU 10</th>
<th>Detector</th>
<th>Phase</th>
<th>Source</th>
<th>Func</th>
<th>BIU 11</th>
<th>Detector</th>
<th>Phase</th>
<th>BIU 12</th>
<th>Detector</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NBLT - Ph 1</td>
<td>field</td>
<td>C, Ext</td>
<td>17</td>
<td>NB Setback (1)</td>
<td>field</td>
<td>C, Ext</td>
<td></td>
<td>33</td>
<td>NB U-Turn</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>49</td>
<td>EB U-Turn</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>SB - Ph 2</td>
<td>field</td>
<td>C, Ext</td>
<td>18</td>
<td>NB Setback (2)</td>
<td>field</td>
<td>C, Ext</td>
<td></td>
<td>34</td>
<td>NB LT (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50</td>
<td>EB LT (1)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>EBLT - Ph 3</td>
<td>field</td>
<td>C, Ext</td>
<td>19</td>
<td>SB Setback (1)</td>
<td>field</td>
<td>C, Ext</td>
<td></td>
<td>35</td>
<td>NB LT (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>51</td>
<td>EB LT (2)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>WB - Ph 4</td>
<td>field</td>
<td>C, Ext</td>
<td>20</td>
<td>SB Setback (2)</td>
<td>field</td>
<td>C, Ext</td>
<td></td>
<td>36</td>
<td>NB Thru (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>52</td>
<td>EB Thru (1)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>SBLT - Ph 5</td>
<td>field</td>
<td>C, Ext</td>
<td>21</td>
<td>EB Setback (1)</td>
<td>field</td>
<td>C, Ext</td>
<td></td>
<td>37</td>
<td>NB Thru (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>53</td>
<td>EB Thru (2)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>NB - Ph 6</td>
<td>field</td>
<td>C, Ext</td>
<td>22</td>
<td>EB Setback (2)</td>
<td>field</td>
<td>C, Ext</td>
<td></td>
<td>38</td>
<td>NB Thru (3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>54</td>
<td>EB Thru (3)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>WBLT - Ph 7</td>
<td>field</td>
<td>C, Ext</td>
<td>23</td>
<td>WB Setback (1)</td>
<td>field</td>
<td>C, Ext</td>
<td></td>
<td>39</td>
<td>NB Thru (4) or 2nd NBRT (LL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>55</td>
<td>EB Thru (4) or 2nd EBRT (LL)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>EB - Ph 8</td>
<td>field</td>
<td>C, Ext</td>
<td>24</td>
<td>WB Setback (2)</td>
<td>field</td>
<td>C, Ext</td>
<td></td>
<td>40</td>
<td>NBRT (1 or RL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>56</td>
<td>EBRT (1 or RL)</td>
<td></td>
</tr>
</tbody>
</table>

### RT/Double Cycle

<table>
<thead>
<tr>
<th>Pin</th>
<th>Label - Cycle</th>
<th>Source</th>
<th>Func</th>
<th>BIU 9</th>
<th>Detector</th>
<th>Phase</th>
<th>Source</th>
<th>Func</th>
<th>BIU 10</th>
<th>Detector</th>
<th>Phase</th>
<th>Source</th>
<th>Func</th>
<th>BIU 11</th>
<th>Detector</th>
<th>Phase</th>
<th>BIU 12</th>
<th>Detector</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>EBRT - Ph 1 or 8</td>
<td>field</td>
<td>C, Ext</td>
<td>25</td>
<td>FYA - NBLT (Ph 1)</td>
<td>1</td>
<td>C, Ext</td>
<td></td>
<td>41</td>
<td>SB U-Turn</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>57</td>
<td>WB U-Turn</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>SBRT - Ph 3 or 2</td>
<td>field</td>
<td>C, Ext</td>
<td>26</td>
<td>FYA - NBLT (Ph 9)</td>
<td>1</td>
<td>C, Ext</td>
<td></td>
<td>42</td>
<td>SB LT (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>58</td>
<td>WB LT (1)</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>WBRT - Ph 5 or 4</td>
<td>field</td>
<td>C, Ext</td>
<td>27</td>
<td>FYA - EBLT (Ph 3)</td>
<td>3</td>
<td>C, Ext</td>
<td></td>
<td>43</td>
<td>SB LT (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>59</td>
<td>WB LT (2)</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>NBRT - Ph 7 or 6</td>
<td>field</td>
<td>C, Ext</td>
<td>28</td>
<td>FYA - EBLT (Ph 11)</td>
<td>3</td>
<td>C, Ext</td>
<td></td>
<td>44</td>
<td>SB Thru (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>60</td>
<td>WB Thru (1)</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>RT/Double #1</td>
<td>varies</td>
<td>C, Ext</td>
<td>29</td>
<td>FYA - SBLT (Ph 5)</td>
<td>5</td>
<td>C, Ext</td>
<td></td>
<td>45</td>
<td>SB Thru (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>61</td>
<td>WB Thru (2)</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>RT/Double #2</td>
<td>varies</td>
<td>C, Ext</td>
<td>30</td>
<td>FYA - SBLT (Ph 13)</td>
<td>5</td>
<td>C, Ext</td>
<td></td>
<td>46</td>
<td>SB Thru (3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>62</td>
<td>WB Thru (3)</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>RT/Double #3</td>
<td>varies</td>
<td>C, Ext</td>
<td>31</td>
<td>FYA - WBLT (Ph 7)</td>
<td>7</td>
<td>C, Ext</td>
<td></td>
<td>47</td>
<td>SB Thru (4) or 2nd SBRT (LL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>63</td>
<td>WB Thru (4) or 2nd WBRT (LL)</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>RT/Double #4</td>
<td>varies</td>
<td>C, Ext</td>
<td>32</td>
<td>FYA - WBLT (Ph 15)</td>
<td>7</td>
<td>C, Ext</td>
<td></td>
<td>48</td>
<td>SBRT (1 or RL)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>64</td>
<td>WBRT (1 or RL)</td>
<td></td>
</tr>
</tbody>
</table>
SPM

• SPM presents data in ways not seen but
• How does a point on a chart relate to the traffic conditions?
Purdue Split Failure

- The chart versus the real world.
- Collected the data for Purdue Split Failure and recorded the approach for a day.
Purdue Split Failure
Purdue Split Failure

- Green dots are the occupancy ratio during the green
- Red dots are the occupancy ratio during the first 5 seconds of the red
Case 1 – 0 to 30% GOR
Case 1 – 0 to 30% GOR
Case 2 – 30 to 80% GOR
Case 2 – 30 to 80% GOR
Case 2 – 30 to 80% GOR
Case 2 – 30 to 80% GOR
Case 3 – 80 to 100% GOR
Case 3 – 80 to 100% GOR
Use Case for GOR

- Changed from coordinated to free
Use Case for GOR

- Green is Free
- Black is Coordinated
Phase Termination

- The chart versus the real world.
- Collected the data for Purdue Split Failure and recorded the approach.
Phase Termination
Phase Termination

Legacy - Veneto ATC 206 Signal 266
Wednesday, May 9, 2018 4:00 PM - Wednesday, May 9, 2018 7:00 PM

Currently showing Force-Offs, Max-Outs and Gap-Outs with a consecutive occurrence of 1 or more.
Pedestrian events are never filtered

Legend
- Gap Out
- Max Out
- Force Off
- Ped Begin Walk
- Ped Begin Clearance
- Unknown Termination Cause

Time (Hour of Day)
Phase Termination
Left Turn Cycle 1
Left Turn Cycle 2
Crowd Source Travel Time

• Received an email – 10 minute backup, horrible.

• Watched traffic and made a signal timing change. Added 10 seconds of green.
  – Did I make the right change?
  – Did I change enough?
Crowd Source Travel Time

- Blue – Before, Orange – During, Gray - After
Crowd Source Travel Time

- 5 minute versus 15 minute data
Crowd Source Travel Time

- 5 minute versus 15 minute data.
Machine Learning

- Determine what in the SPM data indicates a problem. We need to gain experience.
- Machine Learning – user provides feedback to the SPM module.
  - Yes that was a traffic signal problem or
  - No that was not a traffic signal problem.
- From SPM (manual) to ATSPM (automated)
  - Data analytics that provide a “top 10 list” of problems, which are actually problems
  - Don’t need false alarms
Contact

Curtis Jarecki, P.E.
City of Frisco
cjarecki@friscotexas.gov
Tel: (972) 292-5457