Signal System Performance Measures based on Conventional Travel Run Data

Zong Z. Tian, Ph.D., P.E.
Center for Advanced Transportation Education and Research (CATER)
University of Nevada, Reno

CATER
Center for Advanced Transportation Education and Research
Outline

- Beyond the automated Signal Performance Measures (SPMs)
- UNR Research on travel-run-based SPMs
- Case Examples
- Q&A
Automated SPMs

- The good – You have mostly heard!
- Limitations and beyond
  - Thresholds – what is considered good or bad?
  - Link-based performance ≠ arterial performance

Better link performance
Better arterial performance
Automated SPMs

- The good – You have mostly heard!

- Limitations and beyond
  - Thresholds – what is considered good or bad?
  - Link-based performance ≠ arterial performance
  - Still need solution/alternative to improve operations
  - Cost?
*Offsets at all other intersections use EndGreen of Phase 4, except for Durango which uses phase 8.
Initial MD Plan in Naztec NEMA

% Arrival on Red (11/10/15)

EB-66; WB-52

EB-16; WB-17

EB-47; WB-73

EB-32; WB-NA

EB-68; WB-33
FAST Adjusted MD Plan

% Arrival on Red (12/8/15)

EB-61; WB-52
EB-15; WB-16
EB-49; WB-59
EB-26; WB-NA
EB-60; WB-40
MOE Comparison

EB-66; WB-52
EB-16; WB-17
EB-47; WB-73
EB-32; WB-NA
EB-68; WB-33
EB-61; WB-52
EB-15; WB-16
EB-49; WB-59
EB-26; WB-NA
EB-60; WB-40
Orange County’s Performance Index

- Measures of Effectiveness (MOEs)
  - Average Speed (S)
  - Green per Red (GpR)
  - Stops per Mile (SpM)

- Performance index (PI)

\[
PI = 1.5(S - 10) + GpR \times 8 + 40 - SpM \times 10
\]

\[
= 1.5(30 - 10) + 4 \times 8 + 40 - 1 \times 10
\]

\[
= 92
\]
What are Missing?

- **Speed limit or free-flow speed** - Higher speed limit likely results in higher actual speed

- **Cycle length** - Longer cycle length likely results in better arterial travel runs

- **Spacing** – shorter spacing makes progression more difficult

- **Volume level** – higher volume makes progression more difficult
UNR Methodology

• One score based on %Speed

• One score based %Stop – a standard stop is 25% of cycle length

• Weighted score based on both (30% and 70%)
  • Adjustment based on cycle
  • Adjustment based on spacing
  • Adjustment based on V/C

• Final score (100 scale) to determine QOS
# Case Study - Before
Highway 74 – Caltrans District 8

## Corridor Synchronization Performance Index

### Summary

**Arterial: City of Hemet-Hwy 74**

<table>
<thead>
<tr>
<th>Timing</th>
<th>No. of Runs</th>
<th>Average Speed Score</th>
<th>Average Stop Score</th>
<th>Average Score</th>
<th>Quality of Signal Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD</td>
<td>7</td>
<td>72.1</td>
<td>85.9</td>
<td>84.7</td>
<td>B</td>
</tr>
</tbody>
</table>

### Details

**Arterial: City of Hemet-Hwy 74**

**Timing Plan: MD**

<table>
<thead>
<tr>
<th>Timing</th>
<th>GPS File Name</th>
<th>Average Speed (mph)</th>
<th>% Speed</th>
<th>Speed Score</th>
<th>No. of Stops</th>
<th>Standard No. of Stops</th>
<th>% Stop</th>
<th>Stop Score</th>
<th>Original Score</th>
<th>Cycle Length Adjustment</th>
<th>Spacing Adjustment</th>
<th>Adjusted Score</th>
<th>Quality of Signal Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD</td>
<td>0-EB-City of Hemet-2015-10-23</td>
<td>22.9</td>
<td>0.65</td>
<td>75.4</td>
<td>3</td>
<td>2.3</td>
<td>0.23</td>
<td>87</td>
<td>83.5</td>
<td>86.5(+3)</td>
<td>86.5(+0)</td>
<td>86.5</td>
<td>B</td>
</tr>
<tr>
<td>MD</td>
<td>1-WB-City of Hemet-2015-10-23</td>
<td>16.7</td>
<td>0.48</td>
<td>57.7</td>
<td>4</td>
<td>4.1</td>
<td>0.41</td>
<td>69.3</td>
<td>65.8</td>
<td>68.8(+3)</td>
<td>68.8(+0)</td>
<td>68.8</td>
<td>D</td>
</tr>
<tr>
<td>MD</td>
<td>2-EB-City of Hemet-2015-10-23</td>
<td>21.2</td>
<td>0.61</td>
<td>70.6</td>
<td>3</td>
<td>2.5</td>
<td>0.25</td>
<td>85</td>
<td>80.7</td>
<td>83.7(+3)</td>
<td>83.7(+0)</td>
<td>83.7</td>
<td>B</td>
</tr>
<tr>
<td>MD</td>
<td>3-WB-City of Hemet-2015-10-23</td>
<td>21.8</td>
<td>0.62</td>
<td>72.4</td>
<td>4</td>
<td>1.8</td>
<td>0.18</td>
<td>92.3</td>
<td>86.3</td>
<td>89.3(+3)</td>
<td>89.3(+0)</td>
<td>89.3</td>
<td>B</td>
</tr>
<tr>
<td>MD</td>
<td>4-EB-City of Hemet-2015-10-23</td>
<td>22.8</td>
<td>0.65</td>
<td>75.2</td>
<td>3</td>
<td>2.2</td>
<td>0.22</td>
<td>88</td>
<td>84.2</td>
<td>87.2(+3)</td>
<td>87.2(+0)</td>
<td>87.2</td>
<td>B</td>
</tr>
<tr>
<td>MD</td>
<td>5-WB-City of Hemet-2015-10-23</td>
<td>20.4</td>
<td>0.58</td>
<td>68.2</td>
<td>5</td>
<td>3.1</td>
<td>0.31</td>
<td>79.3</td>
<td>76</td>
<td>79(+3)</td>
<td>79(+0)</td>
<td>79</td>
<td>C</td>
</tr>
<tr>
<td>MD</td>
<td>6-EB-City of Hemet-2015-10-23</td>
<td>25.4</td>
<td>0.75</td>
<td>85.4</td>
<td>1</td>
<td>0.6</td>
<td>0.06</td>
<td>100</td>
<td>96.6</td>
<td>98.6(+3)</td>
<td>98.6(+0)</td>
<td>98.6</td>
<td>A</td>
</tr>
</tbody>
</table>
Case Study – After 1
Highway 74 – Caltrans District 8

Corridor Synchronization Performance Index

Summary
Arterial: City of Hemet-Hwy 74

<table>
<thead>
<tr>
<th>Timing</th>
<th>No. of Runs</th>
<th>Average Speed Score</th>
<th>Average Stop Score</th>
<th>Average Score</th>
<th>Quality of Signal Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD-UNR</td>
<td>4</td>
<td>68</td>
<td>84.2</td>
<td>82.4</td>
<td>B</td>
</tr>
</tbody>
</table>

Details
Arterial: City of Hemet-Hwy 74
Timing Plan: MD-UNR

<table>
<thead>
<tr>
<th>Timing</th>
<th>GPS File Name</th>
<th>Average Speed (mph)</th>
<th>% Speed</th>
<th>Speed Score</th>
<th>No. of Stops</th>
<th>Standard No. of Stops</th>
<th>% Stop</th>
<th>Stop Score</th>
<th>Original Score</th>
<th>Cycle Length Adjustment</th>
<th>Spacing Adjustment</th>
<th>Adjusted Score</th>
<th>Quality of Signal Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD-UNR</td>
<td>1-EB-2015-12-16 14-55-02MDUNR</td>
<td>19.4</td>
<td>0.55</td>
<td>65.4</td>
<td>3</td>
<td>2.9</td>
<td>0.29</td>
<td>81.3</td>
<td>76.6</td>
<td>79.6(+3)</td>
<td>79.5(+0)</td>
<td>79.6</td>
<td>C</td>
</tr>
<tr>
<td>MD-UNR</td>
<td>2-WB-2015-12-16 13-55-42MDUNR</td>
<td>18.1</td>
<td>0.52</td>
<td>61.6</td>
<td>5</td>
<td>3.8</td>
<td>0.38</td>
<td>72</td>
<td>68.9</td>
<td>71.9(+3)</td>
<td>71.9(+0)</td>
<td>71.9</td>
<td>C</td>
</tr>
<tr>
<td>MD-UNR</td>
<td>3-EB-2015-12-16 13-46-48MDUNR</td>
<td>19.4</td>
<td>0.55</td>
<td>65.3</td>
<td>3</td>
<td>2.6</td>
<td>0.26</td>
<td>83.7</td>
<td>78.2</td>
<td>81.2(+3)</td>
<td>81.2(+0)</td>
<td>81.2</td>
<td>B</td>
</tr>
<tr>
<td>MD-UNR</td>
<td>4-WB-2015-12-16 14-46-1MDUNR</td>
<td>24.4</td>
<td>0.7</td>
<td>79.6</td>
<td>2</td>
<td>1</td>
<td>0.1</td>
<td>100</td>
<td>93.9</td>
<td>96.9(+3)</td>
<td>96.9(+0)</td>
<td>96.9</td>
<td>A</td>
</tr>
</tbody>
</table>
Case Study – After 1
Highway 74 – Caltrans District 8
TranSync Demo

Caltrans D8 – LT Gap out

Caltrans D8 – Transition
How Travel Runs Should Be Collected?
Summary

- Automated SPMs is a future trend and will change the way we do signal timing.

- Much needs to be done beyond SPMs and improving signal operations is the goal.

- The SPMs can be enhanced with traditional travel-run-based SPMs and with adequate signal timing tools.

- Signal timing plans must be adequately implemented and operated.
Contact: zongt@unr.edu