TRANSIT SIGNAL PRIORITY IN BALTIMORE, A CORRIDOR-BASED STUDY

ANAM ARDESHIRI
SABRA & ASSOCIATES, A MEAD & HUNT COMPANY
INTRODUCTION

- **BaltimoreLink**
  - A complete overhaul and rebranding of the core transit system operating within the city and throughout the greater Baltimore region.
  - Launched June 2017
  - 12 Color coded routes
TRANSIT SIGNAL PRIORITY

• TSP feature on BaltimoreLINK routes
• Corridor-based vs. Intersection-based selection
• 710 signals with at least one CityLink route
• 90 of those with more than one CityLink route
B-LINK TSP FEASIBILITY STUDY

- Prescreening 710 signals
- Multiple operational & geometric factors to develop TSP Feasibility Score for each intersection
TRANSIT-SPECIFIC FACTORS

- Bus Frequency
  1. No. of CityLINK buses /hr on approach direction
  2. No. of CityLINK buses /hr on conflicting direction
  3. No. of Non-CityLINK buses /hr on approach direction
  4. No. of Non-CityLINK buses /hr on conflicting direction

Corridor level values:
- Average Bus Ridership
- Average Bus Speed
- Dedicated Bus Lane
TRAFFIC-SPECIFIC FACTORS

- V/C
- LOS
  - TSP Approach
  - Conflicting Approach
- Slack Time Availability
  Used existing Synchro models

Actuation Status (pretimed vs. actuated)
SPATIAL FACTORS

• Nearside vs. Farside Bus Stop
  • Costly to collect existing condition status
  • Uncertainty about how many can be relocated
  • TSP technology could include less variable dwell time of nearside stops in bus arrival time estimation

➤ Assumed all nearside stops can be moved to farside if the intersection is selected for TSP
## Quantitative Method

The Intersection TSP Feasibility Score ($FS_i$) is calculated as:

$$FS_i = 100 \sum_{j=1}^{13} (f_{ij} \times w_j)$$

### Where:

- $i$: intersection
- $j$: factor

### Key Points:

- Average of AM & PM scores
- Factor weights were assigned based on importance

### Table:

<table>
<thead>
<tr>
<th>INTX ID</th>
<th>INTX NAME</th>
<th>DEDICATED Bus Lane</th>
<th>1 Score</th>
<th>2 Avg Bus Speed on TSP Route</th>
<th>3a LINK Buses/Hr on TSP Route</th>
<th>3b LINK Buses/Hr on Conflicting Route</th>
<th>3c Non-TSP Buses/Hr on Conflicting Route</th>
<th>3d Score</th>
<th>3a Non-TSP Buses/Hr on TSP Route</th>
<th>3d Score</th>
<th>4 Conflicting Route Approach LOS</th>
<th>5 Score</th>
<th>6 Overall Ints. V/C Ratio</th>
<th>7 Score</th>
<th>8 Overall Ints. V/C Ratio</th>
<th>9 Score</th>
<th>10 Prelim vs. Actuated Signal</th>
<th>11 Score</th>
<th>12 Score</th>
<th>13 Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1420</td>
<td>LOVEJOY &amp; MUK</td>
<td>N</td>
<td>0</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>1539</td>
<td>LOVEJOY &amp; PENN</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.9</td>
<td>10.0</td>
<td>0.3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>811</td>
<td>LOWELD &amp; GREENE</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>111</td>
<td>LOWELD &amp; HOWARD</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>116</td>
<td>LOWELD &amp; JACOBY</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>141</td>
<td>LOWELD &amp; PUTNAM</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>192</td>
<td>LOWELD &amp; JAKOB</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>168</td>
<td>LOWELD &amp; SHORT</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>179</td>
<td>LOWELD &amp; SHORES</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>189</td>
<td>LOWELD &amp; SMALL</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>169</td>
<td>LOWELD &amp; SOUTH</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>1234</td>
<td>LOWELD &amp; COMMERCE</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>169</td>
<td>LOWELD &amp; WAY</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>489</td>
<td>LOWELD &amp; MARKETPLACE</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>1533</td>
<td>LOWELD &amp; PRESIDENT</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>853</td>
<td>LOWELD &amp; HAWKINS</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>1851</td>
<td>HIGH &amp; LOMBARD</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>1441</td>
<td>HICKER &amp; LOMBARD</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
<tr>
<td>616</td>
<td>CENTER &amp; LOMBARD</td>
<td>Y</td>
<td>1</td>
<td>11.2</td>
<td>0.5</td>
<td>12.0</td>
<td>0.4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.4</td>
<td>0.7</td>
<td>0.84</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td>24.4</td>
<td>1</td>
</tr>
</tbody>
</table>
CHALLENGES

- Some routes didn’t exist, fully or partially
  - No ridership data
  - No bus travel time data
- Nearside bus stops:
- Conflicting TSP approaches:

<table>
<thead>
<tr>
<th>North Ave</th>
<th>Nearside Stops</th>
<th>Farside Stops</th>
</tr>
</thead>
<tbody>
<tr>
<td>EB Direction</td>
<td>15 48%</td>
<td>16 52%</td>
</tr>
<tr>
<td>WB Direction</td>
<td>19 63%</td>
<td>11 37%</td>
</tr>
</tbody>
</table>
Corridors ranked based on their average score

Other Technical & Non-Technical Factors:
- Implementation considerations
- CBD limitations
  - Preferably no cycle length change,
  - too many buses,
  - Too many peds, etc.
- Traffic signal software system & Comm status

Pilot Corridors:
- Loch Raven Blvd / Kirk Ave
  - 12 TSP signals out of 18 signals
- Greenmount Ave / York Rd
  - 14 TSP signals out of 29 signals
TSP DETAILED ANALYSIS

Updated scores based on:
- Recalculated PCT and FDW
- Recent traffic counts
- Updated Synchro models
- Timing optimization
- Nearside stops & relocation
- Veh & Ped detection status
TSP IMPLEMENTATION

• Upgrade traffic controllers to TSP-enabled
• Transfer controller database
• Establish cellular comm
• Set up & upload database to new central system
• Tested and programmed TSP parameters
QUESTIONS/COMMENTS