Impact of Transit Signal Priority on Bus Service Performance

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Outline

- Objectives
- Background
- Route 10 (Central Avenue) case study
- UPA TSP implementation
- Impact of TSP on bus performance
- Concluding remarks
Objectives

- Various transit strategies to improve service
  - TSP
  - Fare payment type
  - Stop consolidation
  - BRT and others
- Understand the impact of each strategy
- Tool to support transit scheduling, planning, and operation
Transit Performance Analysis Framework

Database Model
- Schedule Data
- AVL Data
- APC Data
- GoTo Card

Arterial Traffic Data

Data Pre-Process

Transit Database

Measures
- Running Time
- Dwell Time at Stop
- Delay at Signal
- Transfer Activity

Applications
- Arrival Time Prediction
- Anomaly Detection
- Ridership Analysis
- Schedule Adjustments
- Bus Travel Time
- TSP Deployment Suggestions
- Visualization
- Real Time Service Management

Environmental Factors (Accidents, Incidents, Weather, etc.)

Transit Performance Analyst

The Transit Performance Analyst is a software tool developed by the University of Minnesota for analyzing transit performance data. The tool allows users to select data from various providers, database versions, routes, and service types. It provides options for analyzing different performance metrics such as arrival adherence, departure adherence, and dwell times. The screenshot shows the user interface with options for selecting data, time points, and various analysis functions. The tool is used for analyzing and improving the performance of transit systems, such as Metro Transit, by identifying areas for improvement and tracking performance over time.
Performance Analysis & Modeling

Analysis
- TP time & on-time performance analysis
- Link travel time, speed analysis
- Route time-space diagram

Modeling
- TP based node model
- Inter-TP link travel time model
- Route model
- Model verification and validation
Local vs. Limited Service

For example …

Regular vs. Limited-Stop (CEUN-51Œ)

<table>
<thead>
<tr>
<th>Route</th>
<th>Northbound</th>
<th>Southbound</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTE 10 Mea.</td>
<td>24 min</td>
<td>22 min</td>
</tr>
<tr>
<td>RTE 10 Sim.</td>
<td>23 min</td>
<td>21 min</td>
</tr>
<tr>
<td>RTE 829 Mea.</td>
<td>20 min</td>
<td>19 min</td>
</tr>
<tr>
<td>RTE 829 Sim.</td>
<td>19 min</td>
<td>18 min</td>
</tr>
</tbody>
</table>

- RTE 10 Measured
- RTE 10 Simulated
- RTE 829 Measured
- RTE 829 Simulated*
Bus Delay and Travel Speed

Other Delays
- Stop Delays: 21%
- Dwell Time: 22%
- In Motion Time: 54%
- Other Delays: 3%

Data Source: NYC MTA and FTA National Transit Database, 2008
What is TSP?

“A tool to help make transit service more reliable, faster, and more cost effective. It has little impact on general traffic and is an inexpensive way to make transit more competitive with the automobile.”

- ITS America TSP planning and implementation handbook
Central Avenue (RTE 10)
A component of Minneapolis Urban Partnership Agreement (UPA)
Bus Route #10
- TSP Intersection
- Bus Stops

University of Minnesota

2nd St SE – 53rd Ave
- 5.5 miles
- 27 TSP Intersections
- 40 Bus Stops
- 10-20 min headway
- Mean TT ~25 min
<table>
<thead>
<tr>
<th>Description of Changes Related to Route 10</th>
<th>Signals</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signals changed from <em>pre-timed</em> to <em>semi-actuated</em> in Minneapolis. (between 2\textsuperscript{nd} and 27\textsuperscript{th})</td>
<td>7/1/2009</td>
<td></td>
</tr>
<tr>
<td>Traffic signal timings implemented in Minneapolis (for general traffic)</td>
<td>10/1/2009</td>
<td></td>
</tr>
<tr>
<td>Traffic signal timings implemented by Mn/DOT and Ramsey County (for general traffic)</td>
<td>12/1/2009</td>
<td></td>
</tr>
<tr>
<td>TSP Signal Timing Parameters installed on all signals</td>
<td>12/1/2009</td>
<td></td>
</tr>
<tr>
<td><strong>Running time reduction of about 2 minutes</strong> on all trips and service types along corridor. Weekday peak route 10 adjusted to coordinate with NorthStar commuter rail schedule.</td>
<td></td>
<td>12/12/2009</td>
</tr>
<tr>
<td>Initial date when <strong>TSP was active</strong> for Route 10 (and at Roseville intersections)</td>
<td>1/1/2010</td>
<td></td>
</tr>
<tr>
<td><strong>10 min. headway limitation</strong> for TSP activation in Minneapolis. (2\textsuperscript{nd} St. to 37\textsuperscript{th} Ave.)</td>
<td>2/25/2010</td>
<td></td>
</tr>
<tr>
<td>Nicollet Mall changed to two-block spacing. Rerouted past Convention Center. Route 829 renumbered to 59. Beginning of 10/59 coordination - 8 trips added to 59</td>
<td></td>
<td>3/20/2010</td>
</tr>
<tr>
<td>Peak 10 and 59 schedules coordinated - 6 Rte 10 trips converted to Rte 59</td>
<td></td>
<td>5/15/2010</td>
</tr>
<tr>
<td>Change to <strong>5 min. late threshold</strong> for all signals</td>
<td>6/1/2010</td>
<td></td>
</tr>
<tr>
<td>Running time increased downtown and beyond 53rd. 3 School trips added to the weekday 10</td>
<td></td>
<td>9/11/2010</td>
</tr>
<tr>
<td>Change to <strong>3 min late &amp; 8-min headway threshold</strong> for all signals</td>
<td>11/26/2010</td>
<td></td>
</tr>
</tbody>
</table>
Four separate months of Transit Data

RTE10 NB - Mean Link Travel Time (Schedule)

RTE10 SB - Mean Link Travel Time (Schedule)
Average TSP Call Durations by Intersection ID (Oct. 2010 EMTRAC data)
Average Link Travel Time

Mean Link Travel Time (AVL/APC vs EMTRAC)

Inter-Timepoint Link

Link Travel Time (min)

LWCE-41CE (NB) 41CE-51CE (NB) 51CE-41CE (SB) 41CE-LWCE (SB)

Link Travel Comparisons (AVL/APC vs. EMTRAC) – Oct. 2010
SB Schedule Adherence

![Bar chart showing SB Schedule Adherence for different time periods and routes.](chart.png)
TSP Improvement

Bus Travel Time on TSP Enabled Segment (CEUN-51CE)

- NB Measured
- NB Schedule
- SB Measured
- SB Schedule

Travel Time (min)

- Nov 08
- Apr 09
- Oct 09
- Oct 10
# TSP Impact (con’t)

<table>
<thead>
<tr>
<th>Trip Travel Time</th>
<th>Nov 08</th>
<th>Apr 09</th>
<th>Oct 09</th>
<th>Oct 10</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trip Dir.</strong></td>
<td><strong>Data Type</strong></td>
<td><strong>Mean</strong></td>
<td><strong>Stdev</strong></td>
<td><strong>Mean</strong></td>
</tr>
<tr>
<td>NB CEUN-51CE</td>
<td>Measured</td>
<td>23.90</td>
<td>3.18</td>
<td>23.38</td>
</tr>
<tr>
<td></td>
<td>Schedule</td>
<td>23.79</td>
<td>2.03</td>
<td>23.24</td>
</tr>
<tr>
<td>SB 51CE-CEUN</td>
<td>Measured</td>
<td>23.25</td>
<td>3.34</td>
<td>23.34</td>
</tr>
<tr>
<td></td>
<td>Schedule</td>
<td>24.11</td>
<td>2.05</td>
<td>23.50</td>
</tr>
</tbody>
</table>

## Trip TT Reduction (Oct 10 - Nov 08) / Nov 08

<table>
<thead>
<tr>
<th>Trip TT Reduction</th>
<th>Measured</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northbound CEUN-51CE</td>
<td>-6%</td>
<td>-13%</td>
</tr>
<tr>
<td>Southbound 51CE-CEUN</td>
<td>-4%</td>
<td>-5%</td>
</tr>
</tbody>
</table>
Concluding Remarks

- Service quality and reliability improvements
  - Fare payment type
  - Low floor, BRT
  - Connectivity
- TSP impact on travel time & schedule adherence
- TSP impact on side street
- Transit performance analyst tool
- Support scheduling & planning
Thank You!

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Bus Arrival Info.

Metro Transit

TSP