Impact of Transit Signal Priority on Bus Service Performance in Minneapolis (12-0621)

By: Chen-Fu Liao

Minnesota Traffic Observatory (MTO), Department of Civil Engineering, and Intelligent Transportation Systems (ITS) Institute, University of Minnesota (UMN)

E-mail: cliao@umn.edu, Phone: (612) 626-1697

Abstract
As a component of the Urban Partnership Agreement (UPA), Minnesota Department of Transportation (MnDOT), Metropolitan Council (MetCouncil), and City of Minneapolis have implemented conditional Transit Signal Priority (TSP) strategy along Central Avenue including 27 signalized intersections in the north of downtown Minneapolis. Transit service performance before and after the TSP deployment was studied. As a result of the TSP deployment, bus schedule was reduced by 2 minutes to take full advantage of the conditional signal priority strategy. A wireless-based TSP algorithm, namely UMN TSP, previously developed was installed and deployed on 4 buses. This study validated the UMN TSP algorithm, namely UMN TSP, previously developed was in-service performance before and after the TSP deployment. Results indicated the UMN TSP algorithm averagely provides additional 3-6% of TT reduction as compared to other buses because of the 3 min. lateness of conditional TSP rule and the shorter schedule time in NB, the buses are more likely to being late and therefore receiving more signal priority. This explains why the NB trips receive more TT reduction compared to the SB trips.

UMN TSP Strategy
Adaptive bus signal priority strategy using GPS/AVL and wireless communications.
- Given extension or red truncation
- TSP acknowledgement factors
  - Request time, Time factor (TF)
  - Bus schedule adherence, Lateness Factor (LF)
- Number of passenger, Passenger Factor (PF)
- Conditional priority based on schedule adherence, speed, location, near/far side bus stop and dwell time estimation
- Headway limitation (8-min.)
- Lateness threshold (3-min.)
- Dwelling

Experiments and Data Analyses
I. Existing TSP Performance Evaluation
- Experiments and Data Analyses
  - Four separate months of transit data (Nov. ’08, Apr. ’09, Oct. ’09 and Oct. ’10)
  - Bus TT performance before and after TSP implementation (’09)
  - Lateness threshold for TSP request was reduced from 5 min. to 3 min. threshold by Minneapolis and Metro Transit in Nov. ’10.
  - Existing TSP system improves the bus TT by about 4-6% after reducing the scheduled TT by about 2 min.

II. UMN TSP Implementation and Evaluation
- Implemented and deployed UMN TSP systems on 4 Route 10 buses
- Compared 4 UMN TSP buses with the other Route 10 buses in a 2-week experiment period (3/28/11 – 4/8/11)

<table>
<thead>
<tr>
<th>Table 2 Route 10 Time Point (TP) Time Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direction</strong></td>
</tr>
<tr>
<td>NB</td>
</tr>
<tr>
<td>LWCE</td>
</tr>
<tr>
<td>SB</td>
</tr>
<tr>
<td>LWCE</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 4 Route 10 TSP-Enabled Segment Travel Time (TT) Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Segment</strong></td>
</tr>
<tr>
<td>NB</td>
</tr>
<tr>
<td>LWCE-41CE-41CE</td>
</tr>
<tr>
<td>SB</td>
</tr>
</tbody>
</table>

Concluding Remarks
- A stand-alone UMN TSP strategy is developed to interface with bus Vehicle Control Unit (VCU) and onboard wireless communication radio.
- Existing TSP implementation reduces average bus TT by about 4-6% on the TSP-enabled segments after 2 min. reduction of Route 10 schedule.
- Performances of four buses using UMN TSP algorithm were compared with the other Route 10 buses. Results indicated the UMN TSP algorithm averagely provides additional 3.6% of TT reduction to Route 10 buses.
- Our streets and highways are getting more and more congested as population grows and more cars enter the transportation system. We hope that providing signal priority to buses can help improve quality and reliability of transit services and thus attract more transit riders.

Acknowledgements
This work is supported by the RTA, USDOT though the ITS Institute and Center for Transportation Studies (CTS) at the University of Minnesota. Many thanks to Metro Transit, EMTRAC, City of Minneapolis, and MnDOT for their invaluable assistance.