Green Line Transit Signal Priority:
Implementation and Lessons Learned

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• 11-mile LRT line
• Primarily street-running
• 16 stations
• Interlined with METRO Blue Line in downtown Minneapolis
METRO Green Line Background
METRO Green Line Background

Street-running LRT

- LRT speed $\leq 35$ mph at intersections
- Lower speeds in downtown and at the University of Minnesota
Traffic signals along the alignment

- 68 traffic signals
- Signal spacing varies from 300 feet to ¼ mile
- Mix of actuated and pretimed signal operations
  - Minneapolis – Eagle and Peek controllers
  - Saint Paul – Econolite controllers
What is Transit Signal Priority?

Transit Signal Priority (TSP)
• Changes to signal timing to assist the efficient movement of transit vehicles

Preemption
• Typically associated with Emergency Vehicle Preemption (EVP) or Railroad Preemption
• Often described as “abrupt” or “disruptive”
What is Transit Signal Priority?

A continuous spectrum from priority to preemption.

Priority
- Coordinated Timings
- Early/Extended Green
- Skipped Left-Turn or Pedestrian Movements

Preemption
- Disrupted Coordination
- Modified Signal Sequence
- Automatic Gates
Green Line Operations

- TSP call sent from upstream signal
- LRT detection at each signal
- TSP call sent to downstream signal
- Signals are interconnected via fiber network
Green Line Operations

48-minute scheduled end-to-end run time
  • Goal of 8 minutes total signal delay
  • Average less than 8 seconds delay per signal

TSP critical to reliable, on-time LRT service
  • Behind-schedule operation results in customer complaints and additional operating costs
  • TSP provides opportunities for schedule recovery after an incident
TSP Challenges

• Many signals with lower volume cross streets
• Signal timing (including TSP) must serve all phases and pedestrians every phase
• Need to accommodate two-way LRT and vehicle progression
• Trains that get out of the coordination band fall further behind schedule
• With TSP and optimized coordination, 20-60+% of trains still stopping at lower volume signals
Predictive Priority: Objectives

• Give LRT the best opportunity to receive a green indication based on predicted arrival of train

• Avoid adding significant additional delay to vehicle or pedestrian phases

• Minimize disruption of signal sequence and traffic operations
Utilize existing infrastructure to measure existing operations:

- LRT detection
- Vehicle detection
- Pedestrian push buttons

Create logic within the controller to monitor:

- LRT stops
- LRT travel time between intersections
- Vehicle delays
- Pedestrian delays

Use the central system to create logs of all intersection data.
### Predictive Priority: Before Conditions

**Example: Data collected 6am to 6pm, Tuesdays through Thursdays**

<table>
<thead>
<tr>
<th></th>
<th>Left Turn Delay</th>
<th>NB/SB Cross Street</th>
<th>NB/SB Pedestrians</th>
<th>EB Trains</th>
<th>WB Trains</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fairview/University</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hours of Analysis</td>
<td>36</td>
<td>71</td>
<td>2,070</td>
<td>58</td>
<td>2,242</td>
</tr>
<tr>
<td>Delay (sec)</td>
<td>58</td>
<td>2,242</td>
<td>56</td>
<td>570</td>
<td></td>
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<tr>
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<td>Number of observations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stops at Signal</td>
<td>175</td>
<td>213</td>
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<tr>
<td>Number of Trains</td>
<td>82%</td>
<td>65%</td>
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<tr>
<td>Number of Trains</td>
<td>216</td>
<td>213</td>
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Predictive Priority: Process

Develop and test new controller databases

- Use LRT detection from intersection immediately upstream
- Serve LRT phase when train arrives at intersection, if possible
  - EVP overrides LRT call
  - Pedestrian clearance always served
  - Minimum vehicle phases always served
- Serve other phases with demand immediately after LRT clears
  - Gives left-turn and cross street traffic more opportunities to be served, especially during longer cycle lengths
Predictive Priority: Process

Implement new programming and monitor results

- Use controller data and observations to identify impacts and determine if adjustments are needed
Predictive Priority: After Conditions

Example: Data collected 6am to 6pm, Tuesdays through Thursdays

- Reduced delay for left-turn and cross street vehicles
- Slight increase in delay (+3 sec) for cross street pedestrians

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<tr>
<td>53</td>
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Predictive Priority: Results

• Reduced signal delay and LRT run times
  • Travel times in Saint Paul dropped from 34-35 minutes to under 27 minutes
• Reduced variability in LRT run times
• Reduced vehicle delay
• No significant change in pedestrian delay
Before Conditions: August 2014

Schedule time of 27 to 28 min

LRT Trips between Westgate Station and Union Depot Station
After Conditions: December 2014

Schedule time of 27 to 28 min

LRT Trips between Westgate Station and Union Depot Station
Predictive Priority: Results

- 4 to 5 minute reduction in travel times (10 to 15%)
- 25% increase in on-time performance
- Elimination of 13th consist (gap train)
- Improved customer experience
Lessons Learned

- Robust detection system is critical
  - Provides maximum flexibility in operations
- Involve signal controller vendors early and often
- Identify operational priorities and understand trade-offs
- Data-driven approach demonstrated the benefits and lack of impacts for all modes
Acknowledgements

- City of Saint Paul Traffic Operations
- Traffic Control Corporation
- Metro Transit Rail Operations
More Information

Online:
www.metrotransit.org

Twitter:
www.twitter.com/MetroTransitMN