Green Line Transit Signal Priority:

Implementation and Lessons Learned

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METRO Green Line Background

- 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

METRO Green Line Background

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”

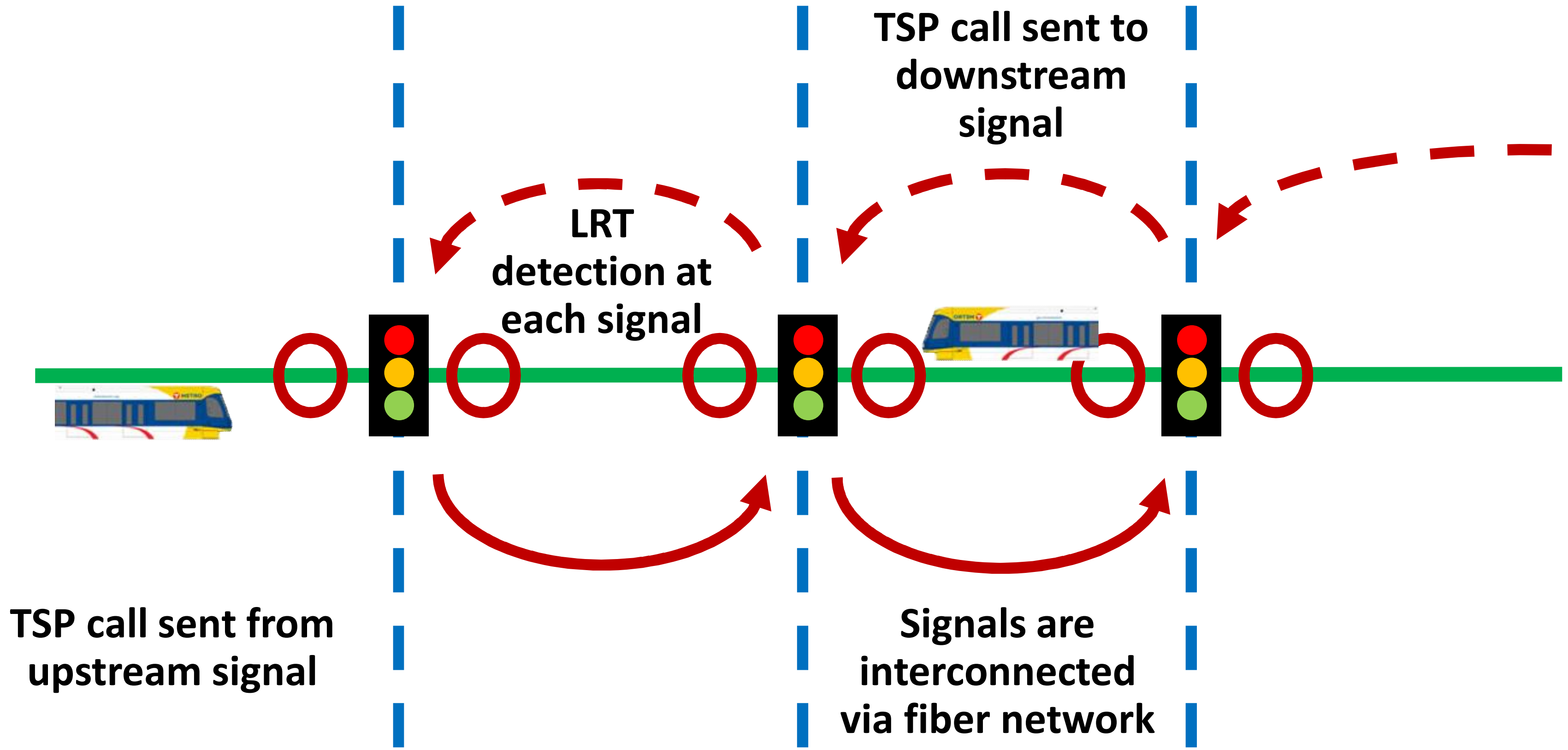
What is Transit Signal Priority?

A continuous spectrum from priority to preemption.

Priority → Preemption

- Coordinated Timings
- Early/Extended Green
- Skipped Left-Turn or Pedestrian Movements
- Disrupted Coordination
- Modified Signal Sequence
- Automatic Gates

Green Line Operations



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

Predictive Priority: Process

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

Fairview/ University	Left Turn Delay		NB/SB Cross Street		NB/SB Pedestrians		EB Trains		WB Trains	
Hours of Analysis	Delay (sec)	Number of observations	Delay (sec)	Number of observations	Delay (sec)	Number of observations	Stops at Signal	Number of Trains	Stops at Signal	Number of Trains
36	71	2,070	58	2,242	56	570	175 82%	213	141 65%	216

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

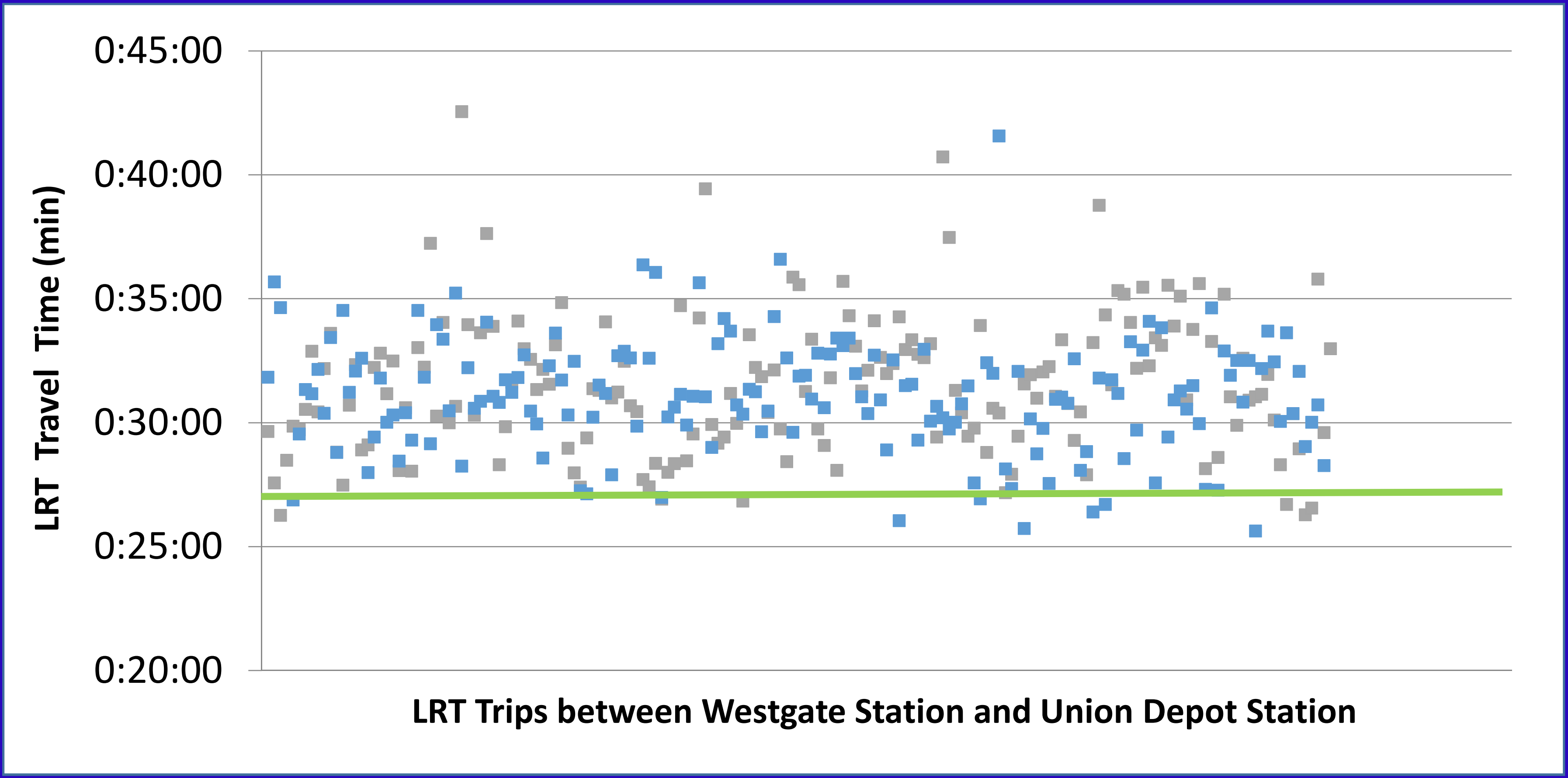
Fairview/ University	Left Turn Delay		NB/SB Cross Street		NB/SB Pedestrians		EB Trains		WB Trains	
Hours of Analysis	Delay (sec)	Number of observations	Delay (sec)	Number of observations	Delay (sec)	Number of observations	Stops at Signal	Number of Trains	Stops at Signal	Number of Trains
53	46	3,646	44	3,280	59	702	6 2%	176	21 8%	276

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

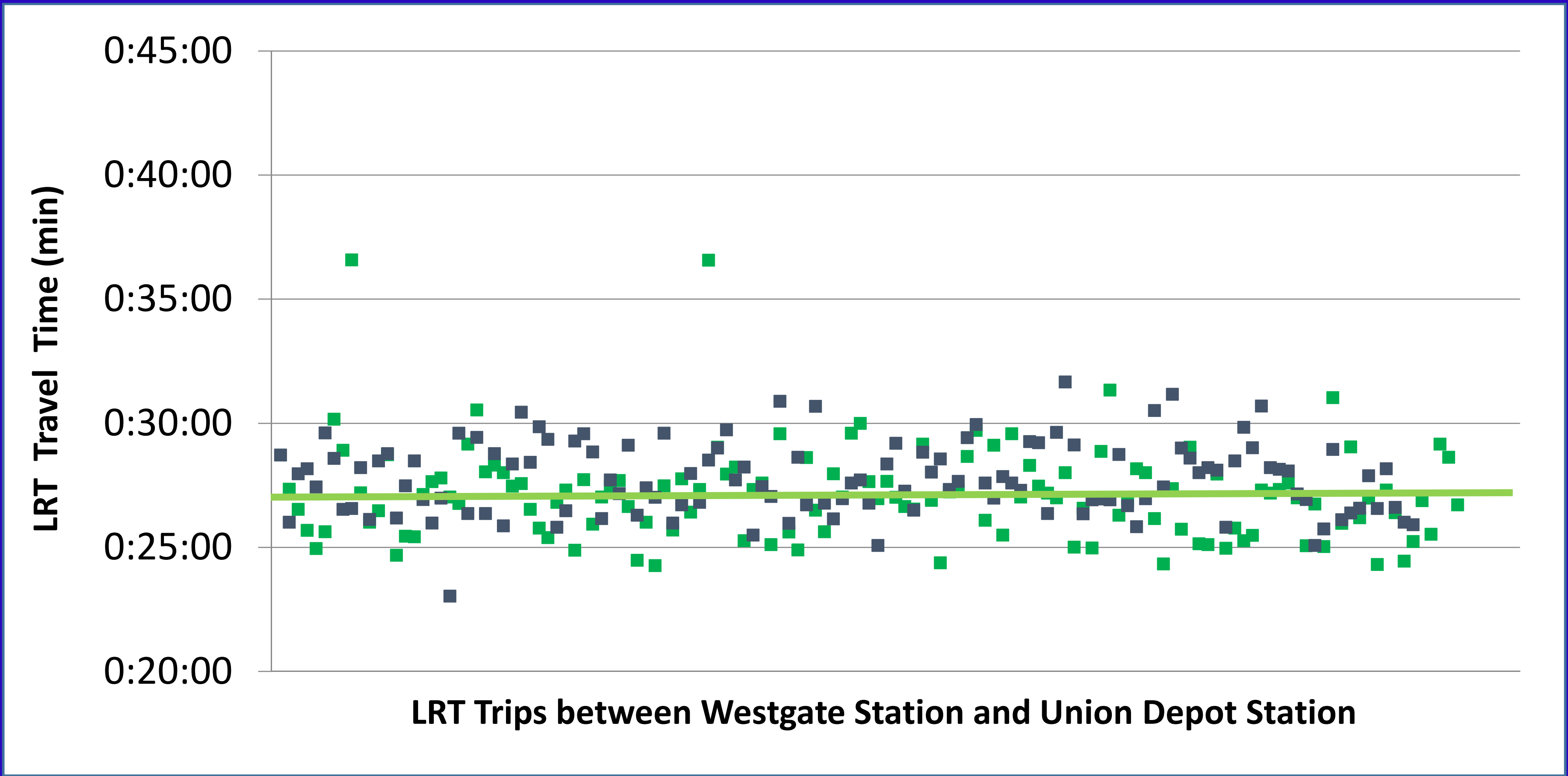
Before Conditions: August 2014

Schedule time of 27 to 28 min



After Conditions: December 2014

Schedule time of 27 to 28 min



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