Modeling of Streetcar and Bus TSP in Toronto using Aimsun Microsimulation Software

ITS Canada Annual Meeting
Monday May 2\textsuperscript{nd}, 2016
Rajnath Bissessar, City of Toronto
Matthew Juckes, TSS
Outline

• Introduction
• Pilot Corridors
• Signals and TSP Algorithms
• API development for Aimsun
• Model Development in Aimsun
• Application within Aimsun
Introduction

The City of Toronto

- Approximately 2.8 million people;
- Annual TTC ridership of over 500 million trips;
- Over 160 bus lines & 10 Streetcar lines;
Pilot Corridors

- Bathurst Corridor
- Dundas Corridor
Pilot Corridors

- Bathurst Street;
  - Bus operations;
  - 48 signals;
  - 15 kilometer long N/S corridor;
  - Several heavy pedestrian/car intersections;
  - Team Lead - HDR
Pilot Corridors

- Dundas Street;
  - Streetcar operations;
  - 37 signals;
  - 10 kilometer long E/W corridor;
  - Several heavy pedestrian/car intersections;
  - Team Lead IBI
## Interval-Based Timing

**Location**: Spadina Ave & Dundas St W

**Mode/Comment**: FXT with 2-wire Polara APS and Transit PE 55 & 5B

**Prepared/Checked By**: JM

**Prep Date**: April 27, 2015

**District**: Toronto & East York

**MTSS**: Novax 30 cct / M

**Red & Red**: 1.0 m/s (FDW based on full crossing at 1.2 m/s)

### Streets

<table>
<thead>
<tr>
<th>COMPUTER INT.</th>
<th>Spadina Ave</th>
<th>Transit</th>
<th>Dundas St W</th>
<th>Transit</th>
<th>North-South Arrow</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSG &gt; &gt; NSY</td>
<td>ALLR</td>
<td>EWG &gt; &gt; EWY</td>
<td>ALLR</td>
<td>NSG &gt; &gt; NSD</td>
<td>EWK &gt; &gt; EWFD</td>
<td>No Call</td>
</tr>
<tr>
<td>NSWG &gt; NSFD</td>
<td>APS</td>
<td>NSY</td>
<td>NSWD</td>
<td>APS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASPECT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Controller INT.**

| IMP. Date | CL | C/S | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | Schedules |
|-----------|----|----|---|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|-------|
| April 27, 2015 | 90 | C151 | 2 | 17 | 13 | 4 | 3 | 0 | 0 | 2 | 2 | 3 | 25 | 4 | 0 | 0 | 3 | 3 | 3 | 3 | All Other Times |
| 90 | C251 | 2 | 16 | 13 | 4 | 3 | 0 | 0 | 2 | 2 | 4 | 25 | 4 | 3 | 0 | 0 | 3 | 3 | 3 | 3 | 06:30 - 09:30, Mon-Fri |
| 90 | C351 | 2 | 17 | 13 | 4 | 3 | 0 | 0 | 2 | 2 | 4 | 25 | 4 | 3 | 0 | 0 | 3 | 3 | 3 | 3 | 15:30 - 18:30, Mon-Fri |

**Notes**: Two decision points for NS transit turn-out phase, however only second one is used.
Phase-Based Timing

Page 1 – Basic

Page 2 – TSP
Toronto’s TSP Operations

- **Active Priority Control Strategy**
  - Priority given to transit vehicle following detection
  - Detection via transit loops

- **Unconditional Priority Requests**
  - First Sequenced, First Serve

- **Generally PEEK ATC-1000 controllers**
  - Other NEMA controllers for special cases
Overview of TSP Features

• Existing TSP Features:
  - Green Extension
  - All Direction Transit Priority
  - Phase Truncation (i.e. Early Green)
  - Call/Extend Special Transit Phases
  - Multiple TSP Opportunities per cycle
  - Shifting and skipping phases

• Recovery after TSP
  - Offset Correction
Extension Algorithms

• Current green extension algorithms
  - Algorithm “A”: Green/Walk extension;
  - Algorithm “B”: Green/SDW extension;

• Enhanced Algorithms
  - Algorithm “C” included as part of pilot;
  - Algorithm “D” not included;
Green Extension

Cancel Loop (Check-Out)

Priority Operating Zone (POZ)

Request Loop (Check-In)
Algorithm A

- **Advantages:**
  - Few Failed Extensions (30 s max.)
  - More ped friendly

- **Disadvantages:**
  - Less Efficient signal operation (with longer FDW)
  - Not practical everywhere
Algorithm B

- **Advantages:**
  - Efficient Signal operation
  - Practical with closely spaced signals

- **Disadvantages:**
  - More Failed extensions (16 s max.)
  - Less ped Friendly
Algorithm C

• Advantages:
  - Fewer Failed extensions
  - Improved efficiency (w.r.t. “A”)
  - More ped friendly than “B”

• Disadvantages:
  - Less efficient than “B”
  - Not practical everywhere
TSP API Development

- Transit only Detection

Vehicle Setting

Detector Setting
TSP API Development

- GUI for attribute creation
TSP API Development

- GUI for attribute creation

Transit Run Attributes

Phase Split Attributes

Phase Offset Correction Attributes
Phases (splits)

- The duration of the interphase is AMB + ALR
- The duration of the phase without pedestrians is FDW
- The duration of the phase for vehicles + pedestrians is the rest of the split
Phase parameters (vehs + peds) - Actuated

- In split 2 and 6 -> Recall = Coord
- Minimum green = WLK
- Max out = SPLIT - AMB - ALR - FDW
**Phase parameters (vehs) - Actuated**

- **Recall** = Max
- **Minimum green** = FDW
- **Force-off** = \( \text{prev force-off} + \text{Max out} \)
- **Max out** = FDW
- **Permissive from** = 0
- **Permissive to** = \( \text{force-off} - \text{minimum green} \)
Detector Coding - TSP Activation

- **Real World Placement**

- **Model Placement**
  - Offset need to place detector beyond the stop line

![Diagram](image-url)

- Stop line
- Cancel Loop
- Request Loop

![Table](image-url)

- Detector: 8637 (Layer: Bathurst_model_network_ver6_clark)
  - Name: undefined
  - OSM Group: undefined
  - OSM Type: unclassified
  - Position Offset: 18.0000

- Presence - SI - Last Generated: 2602
Detector Coding - Streetcar Stops

- Use of detectors to model the stopping of vehicles when the back door of the street car is open.
Model Calibration

- Modeled Section Flows - Bathurst
Model Calibration

- Modeled Turn Flows - Bathurst
Model Calibration

- Modeled Transit Travel Times - Bathurst AM

Northbound

Southbound
Model Calibration

- Modeled Transit Travel Times - Bathurst PM

Northbound

Southbound
Simulation Video
Questions

Rajnath Bissessar, P.Eng
Manager - Intelligent Transportation Systems (Operations)
City of Toronto Traffic Management Centre
Transportation Services Division
703 Don Mills Road
Toronto, ON M3C 3N3
Email: rajnath_bissessar@toronto.ca
Phone (office): 416-392-8826

Matthew Juckes
Principal Consultation
Transport Simulation Systems, Inc.
20 West 22nd Street, Suite 712
New York, NY, 10010
Email: matthew.juckes@aimsun.com
Phone: 917-515-3830
COME SEE US AT BOOTH 20!