

NSERC PARTNERSHIP WORKSHOP

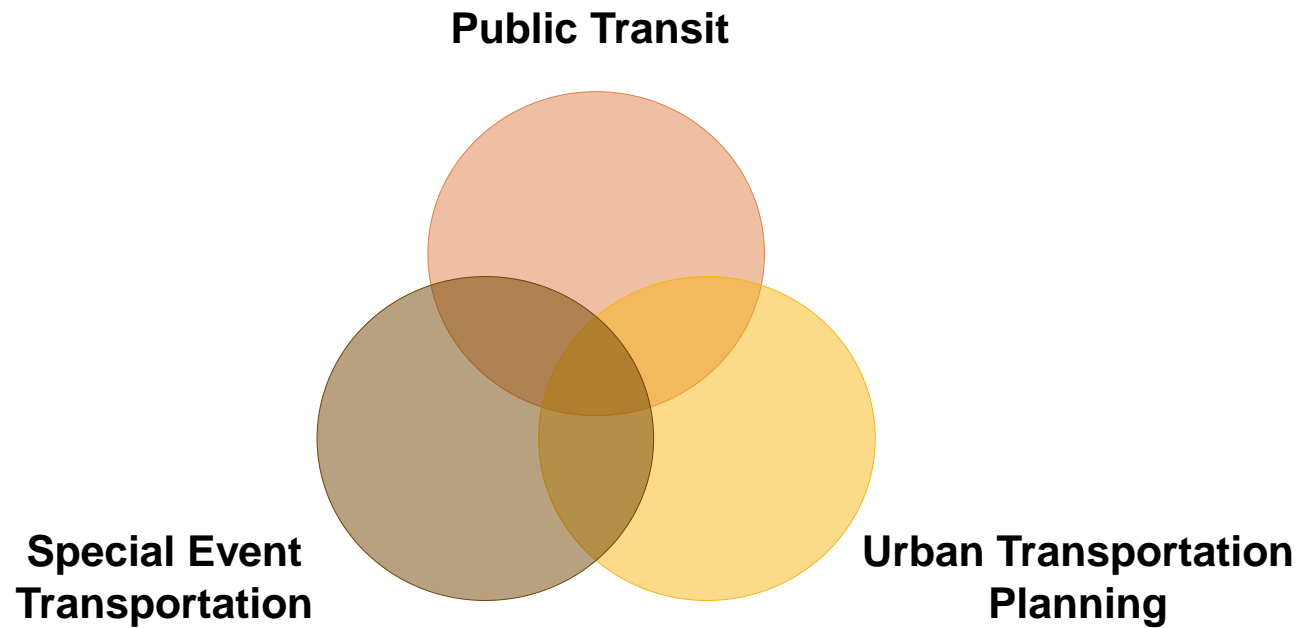
ENHANCING INTERMODAL PASSENGER TRAVEL IN CANADA

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Overall Research Scope



Transit Research Streams

Transit System Analysis

- Conduct detailed investigations of existing transit services to improve our understanding of system performance

Transit ITS Solutions

- Develop and test new ITS solutions to improve the quality and efficiency of our transit systems

Transit Service Planning

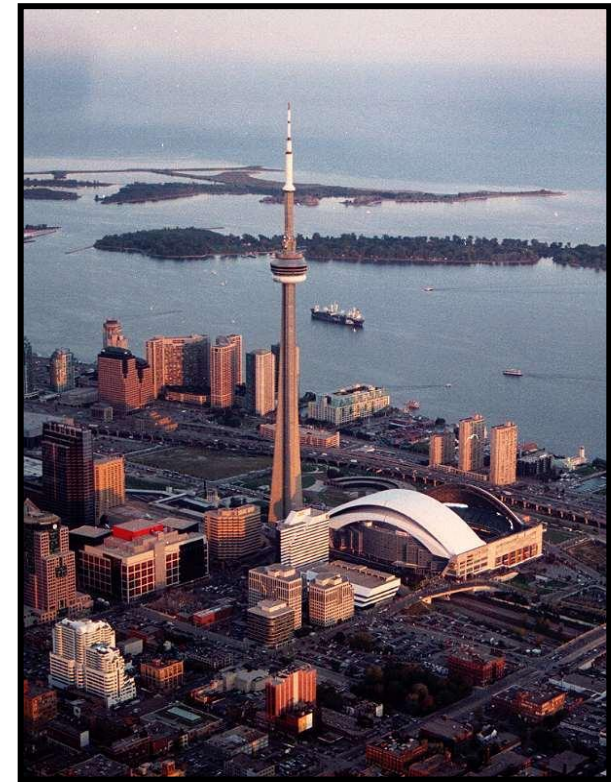
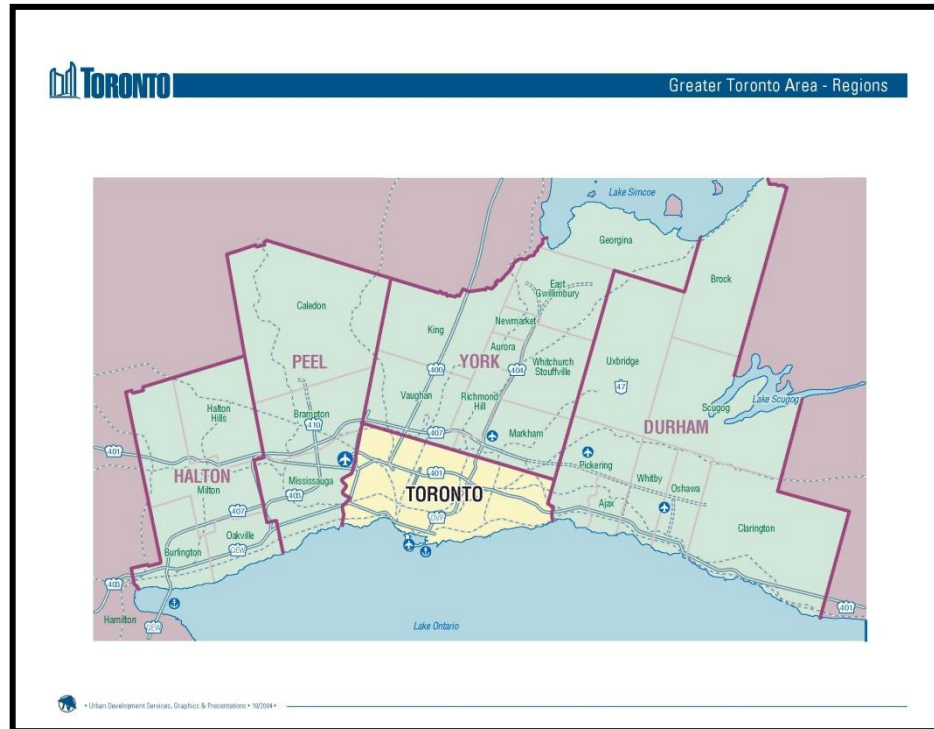
- Develop new decision support tools to facilitate effective planning of modern transit systems

Transfers in Public Transit

- Develop analytical tools for effective planning and management of intra-modal and inter-modal transfer systems

Quick Facts about the GTA

- Located in Southwestern Ontario
- Consists of City of Toronto plus 4 regions
- 25 municipalities

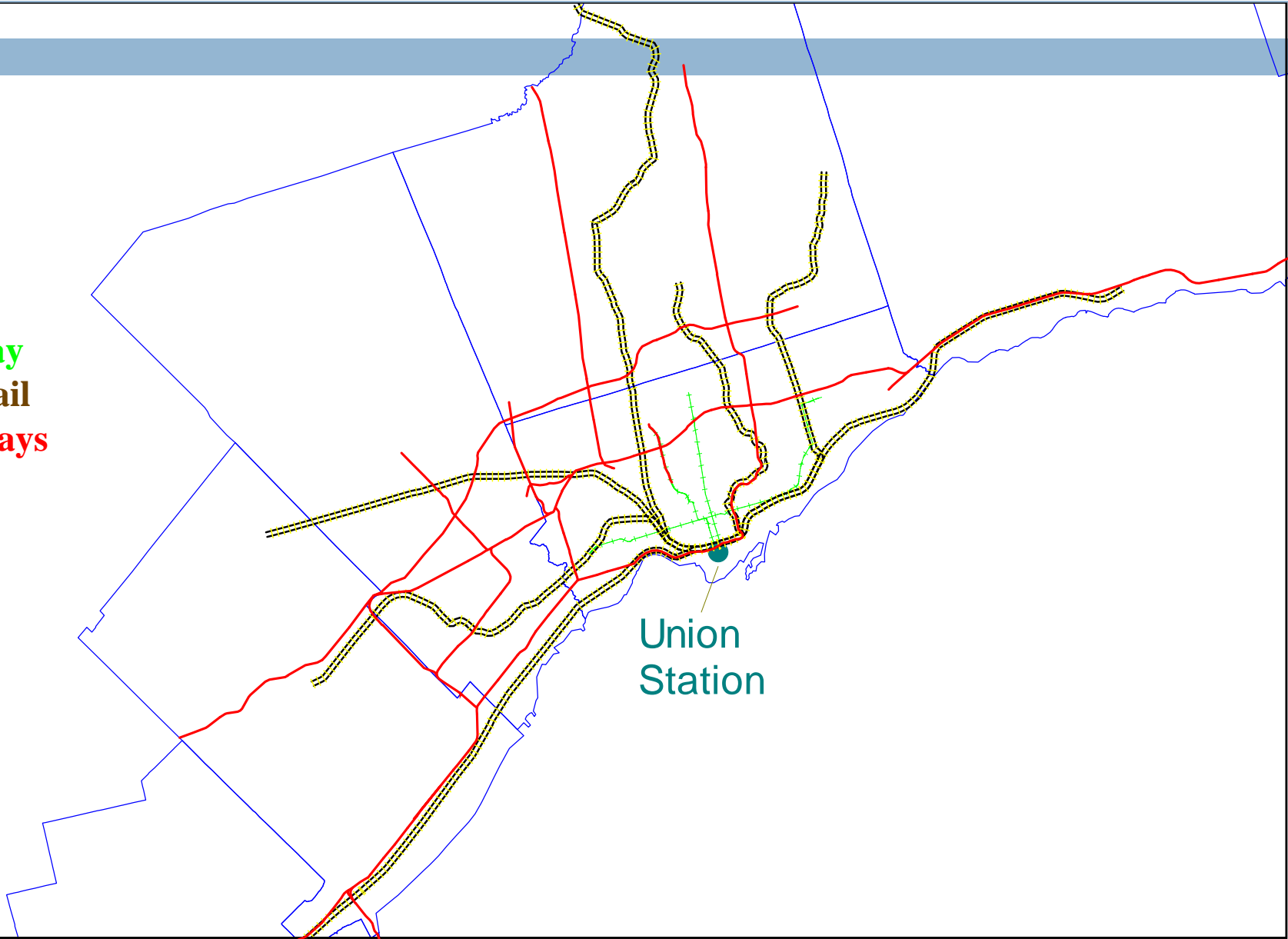


- 5+ million residents - largest in Canada and 5th largest in NA
- 7,100 Km²

Rail Rapid Transit and Freeways

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Subway
GO Rail
Freeways



Union
Station

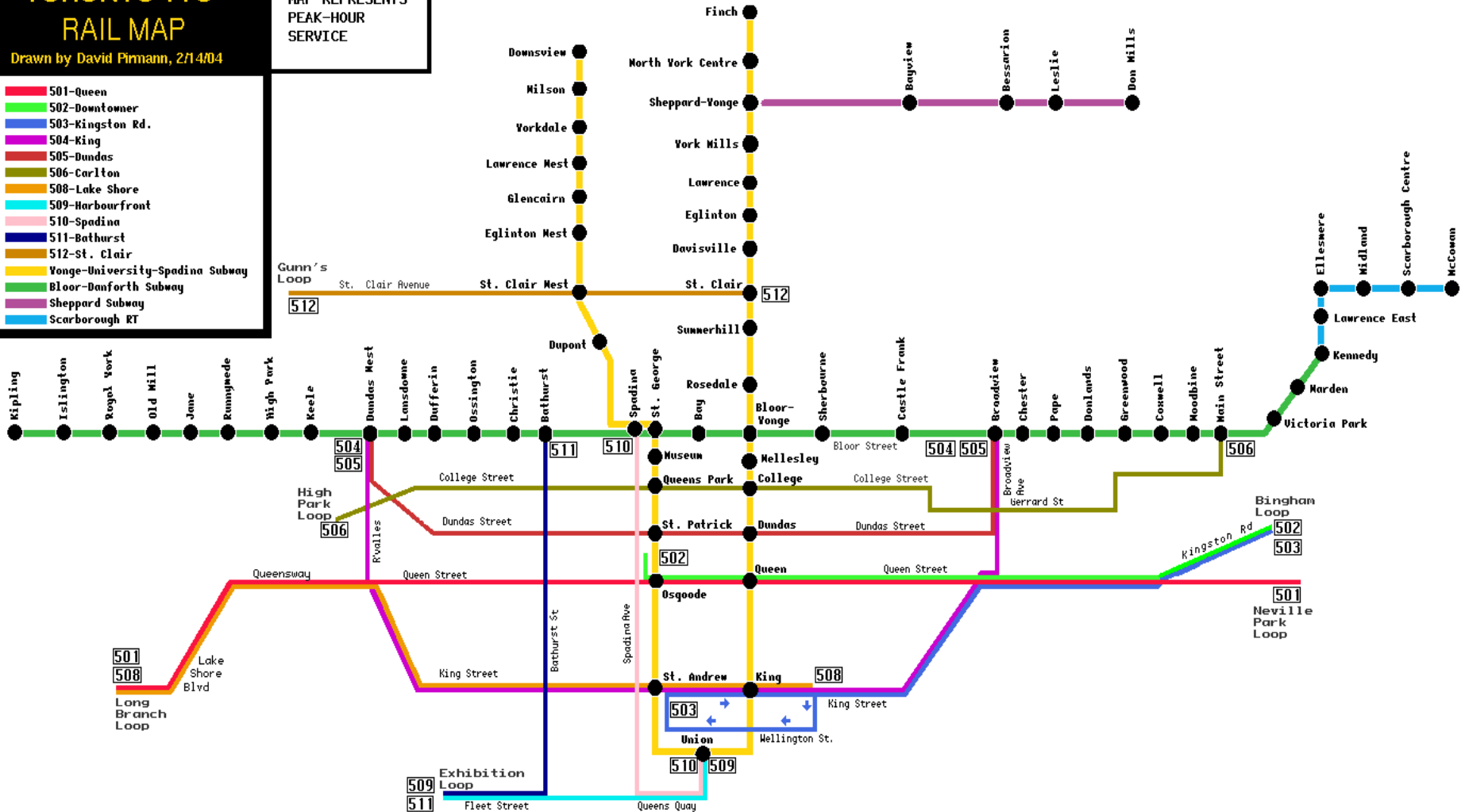
Toronto Rail Network

TORONTO TTC RAIL MAP

Drawn by David Pirmann, 2/14/04

- █ 501-Queen
- █ 502-Downtowner
- █ 503-Kingston Rd.
- █ 504-King
- █ 505-Dundas
- █ 506-Carlton
- █ 508-Lake Shore
- █ 509-Harbourfront
- █ 510-Spadina
- █ 511-Bathurst
- █ 512-St. Clair
- █ Yonge-University-Spadina Subway
- █ Bloor-Danforth Subway
- █ Sheppard Subway
- █ Scarborough RT

MAP REPRESENTS
PEAK-HOUR
SERVICE







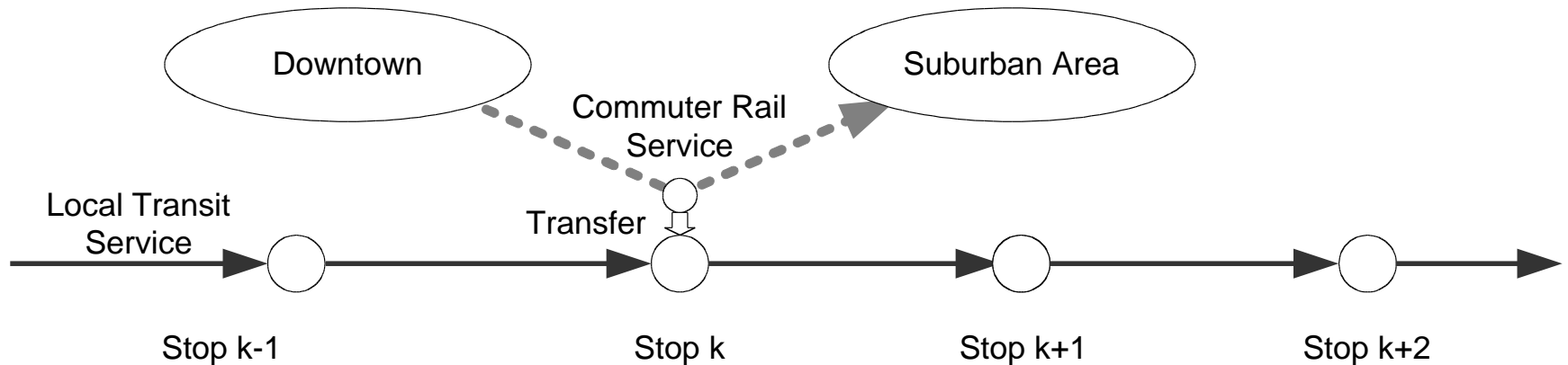
Intermodal Research Overview

- Supply side research
 - ▣ Transfer management
 - Schedule coordination
 - Connection protection
 - ▣ Flex-route transit
 - ▣ Transfer station dynamics

- Demand side research
 - ▣ Mode choice modelling
 - ▣ Transit assignment modelling

Transfer Management

- Project sponsored by Transport Canada and MTO (2006-08)
- Transfer between a Commuter Rail/Bus and a Local Bus Route

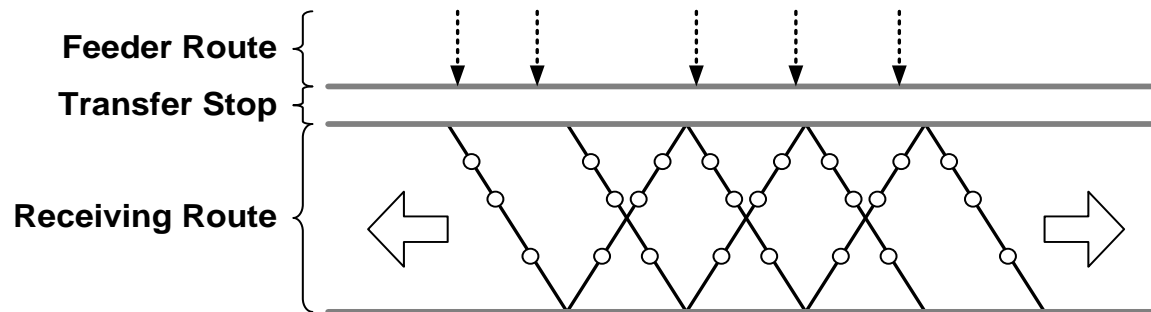


Transfer Management

Schedule Coordination

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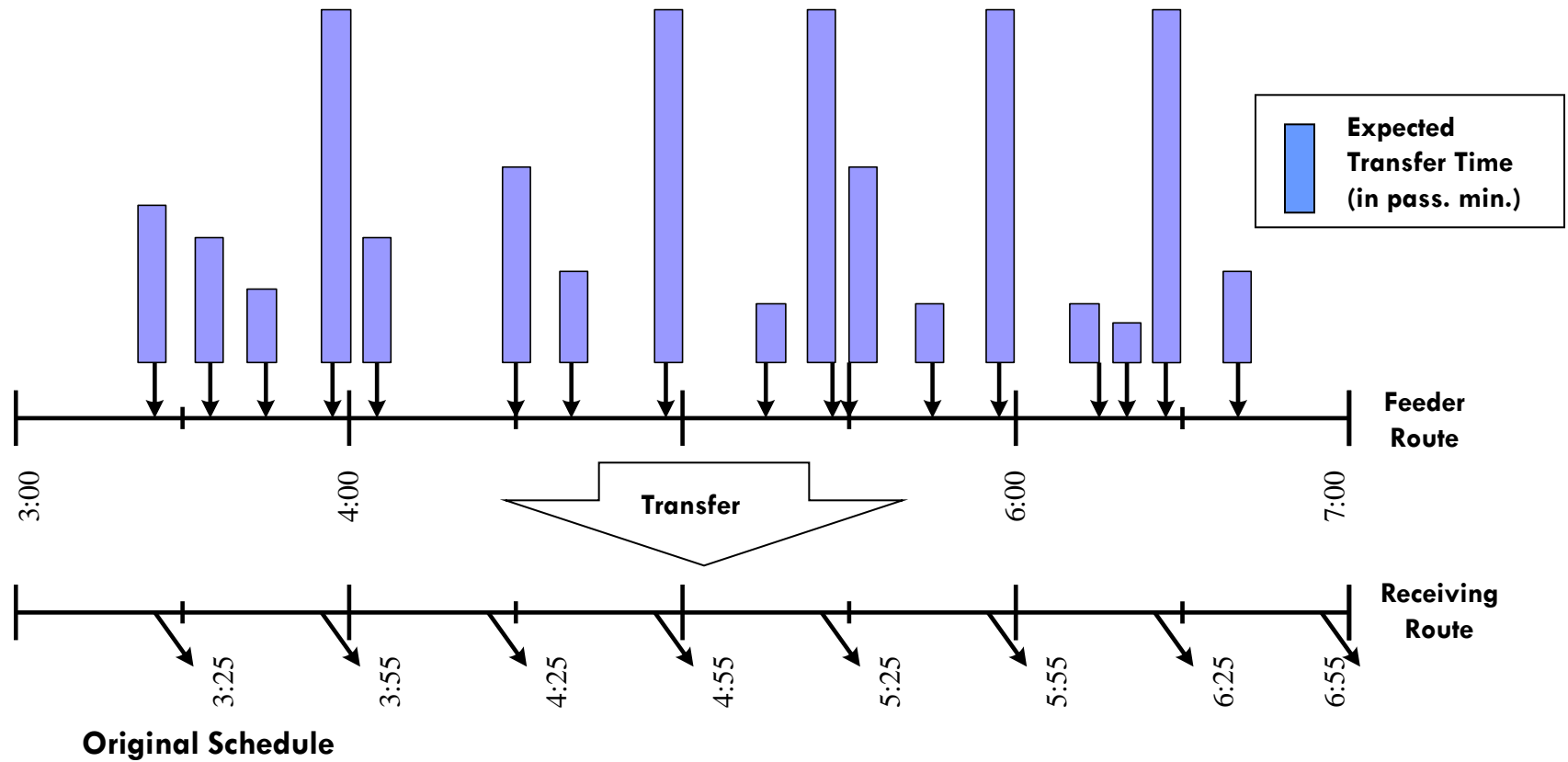
- Objective to schedule transit services at transfer locations in a coordinated manner so as to reduce the overall disutility of transfers for affected passengers
- Modifying (shifting) the existing schedule of a transit route
 - Find an offset value that minimizes overall expected transfer time



Transfer Management

Schedule Coordination

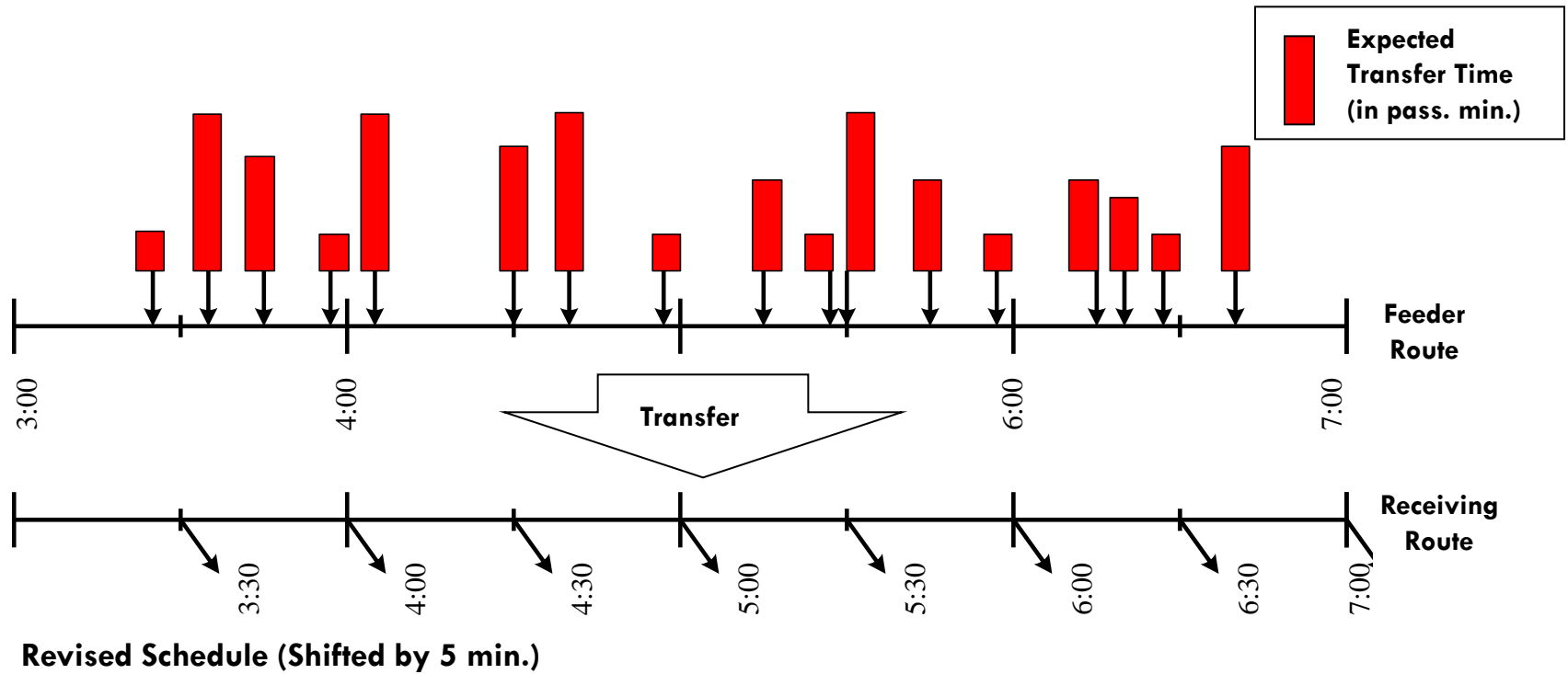
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Transfer Management

Schedule Coordination

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Transfer Management

Connection Protection

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- Project sponsored by Transport Canada and MTO (2006-2008)
- Objective is to protect transfers from one transit line to another transit line where the scheduled timed transfer (i.e. connection) has been broken
- The delay of commuter rail (beyond the scheduled departure time of local transit) results in the failure of the coordinated transfer
- CP control would hold local transit vehicle for the late transfer passengers

Transfer Management

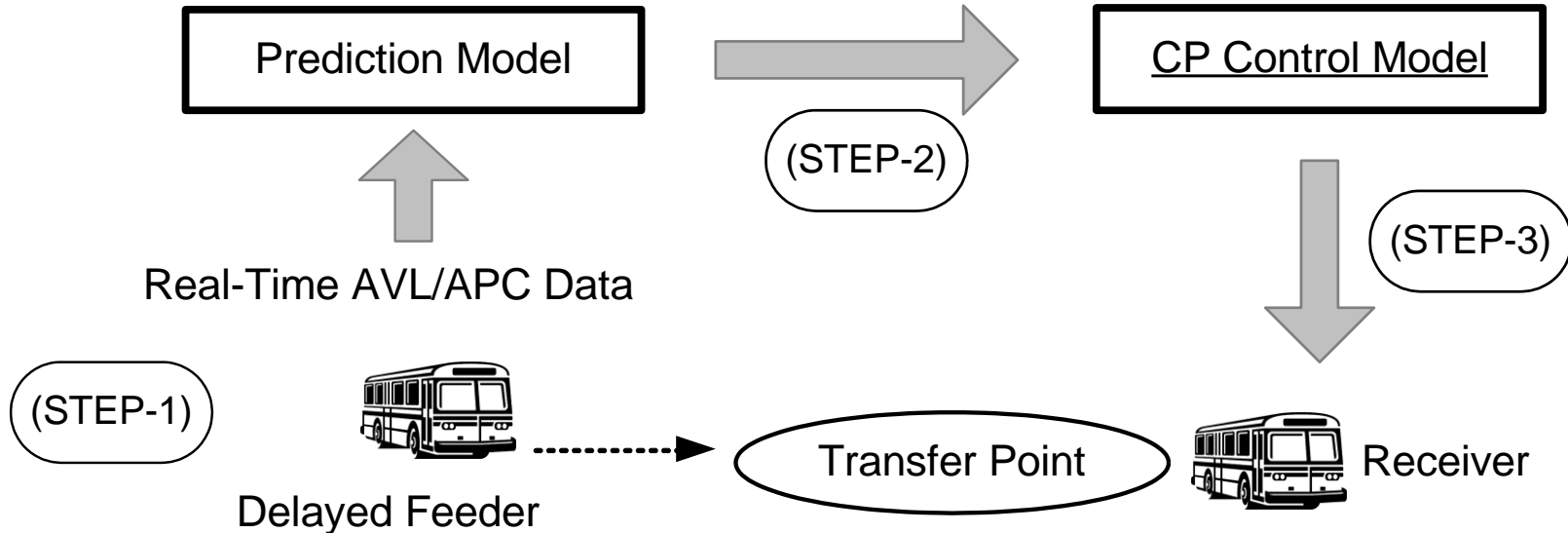
Connection Protection

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Step-1) Activate CP control (when a planned coordination is broken)

Step-2) Predict the arrival time of commuter transit

Step-3) Make a holding decision and apply it to local transit

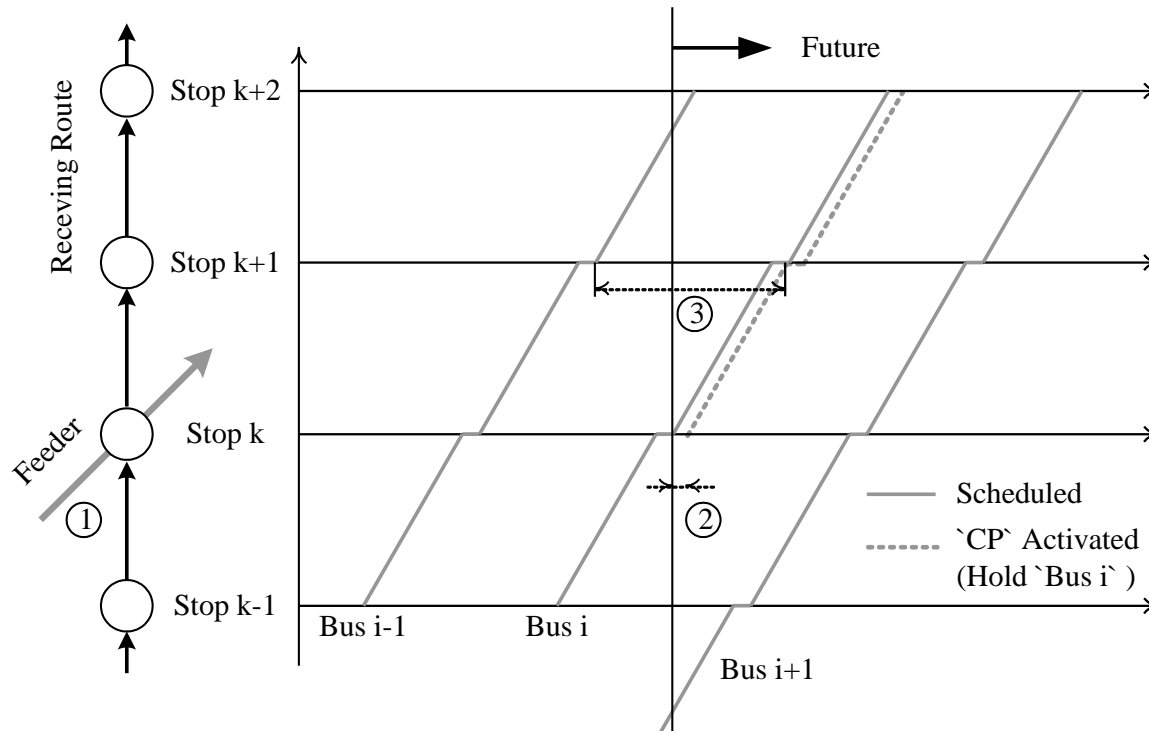


Transfer Management

Connection Protection

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- When Feeder is delayed, if we hold Receiver (Bus i)...
 1. Waiting time of passengers who transfer to Bus i at Stop k : **Benefit**
 2. Waiting time of passengers in Bus i : **Cost**
 3. Waiting time of passengers who wait for Bus i at downstream stops : **Cost**



Benefit vs Cost

IF Benefit > Cost

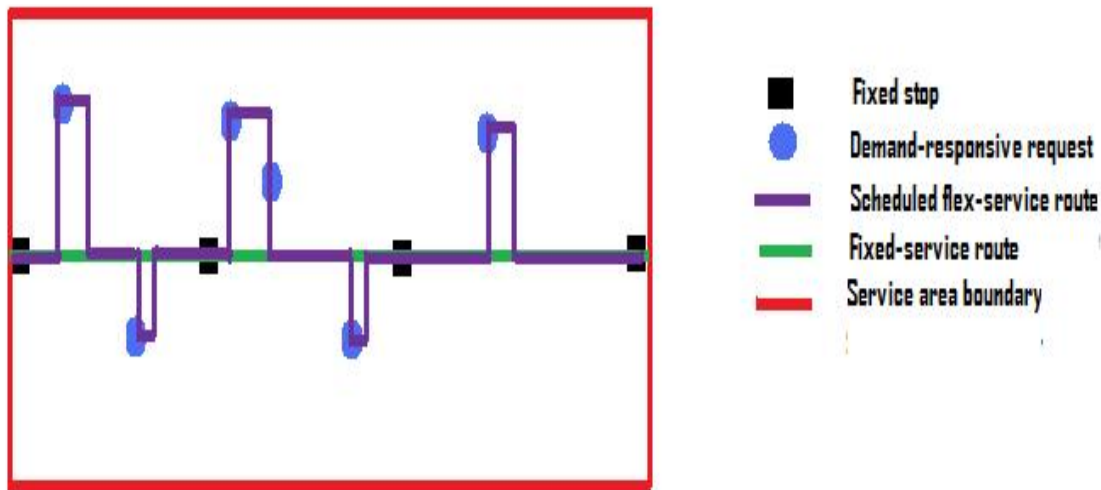
Hold Bus i

Else

Depart Now

Flex-route Transit Scheduling

- Project sponsored by Transport Canada and MTO (2006-08)



- Developed a dynamic scheduling system based on optimizing an objective function of maximizing the number of accepted requests and minimizing the delay for fixed-route passengers

Transfer Station Dynamics

PnR-Sim

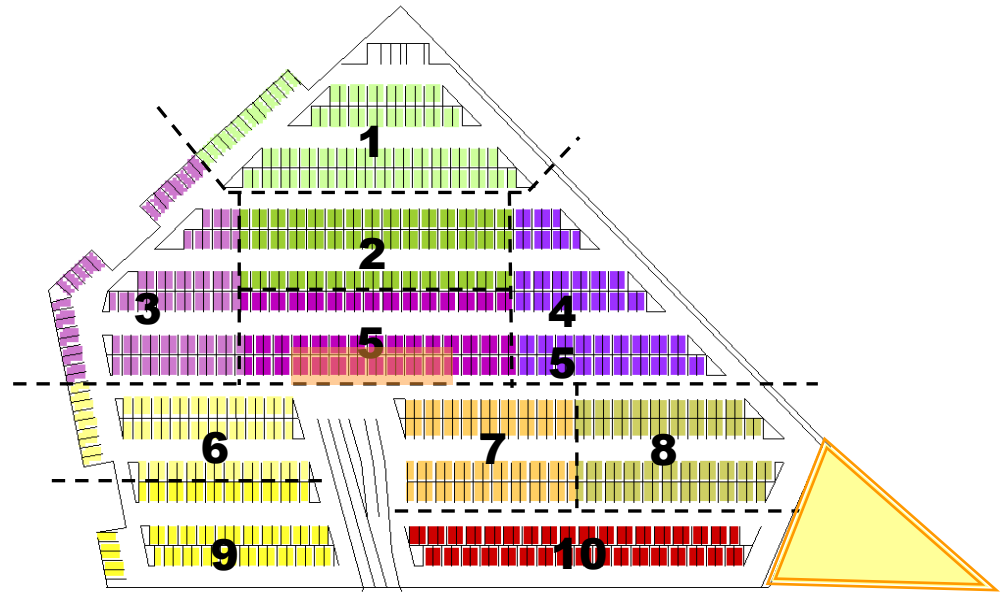
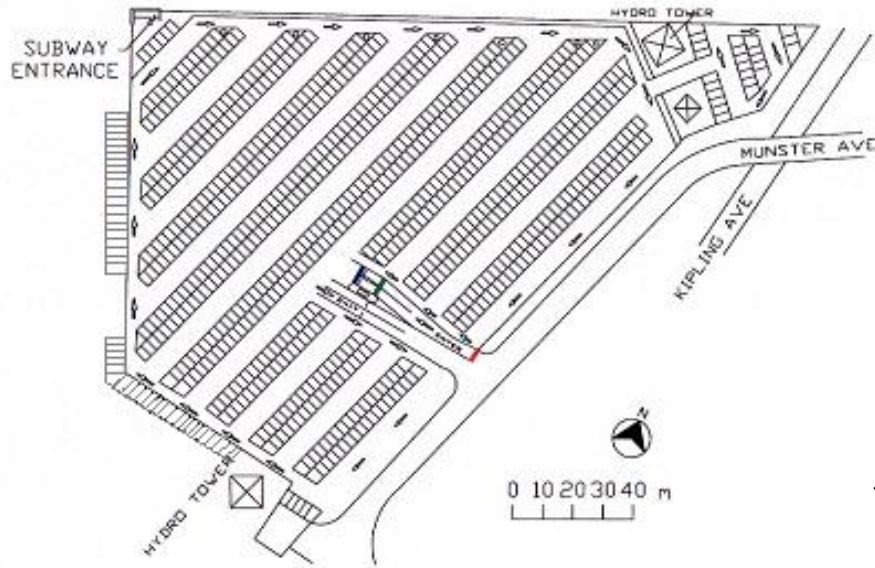
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- Simulation model of the vehicle and passenger dynamics in park-and-ride lots

- Features
 - ▣ Provides a platform for the assessment of alternative P&R lot designs
 - ▣ Provides accurate estimates of transfer times between auto and transit
 - ▣ Based on Cellular Automata approach

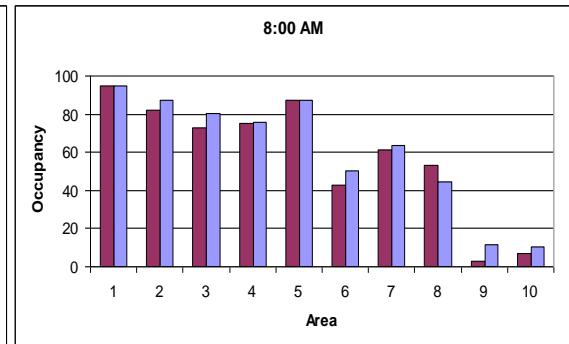
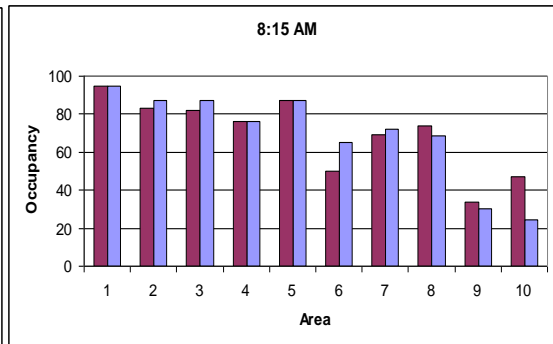
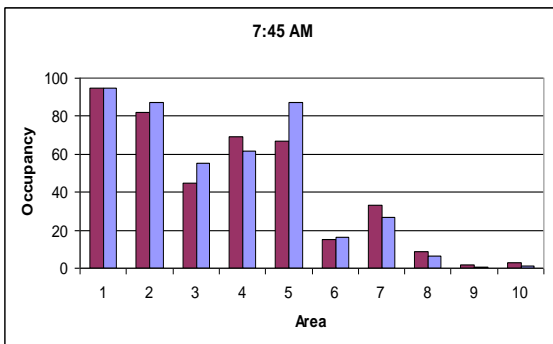
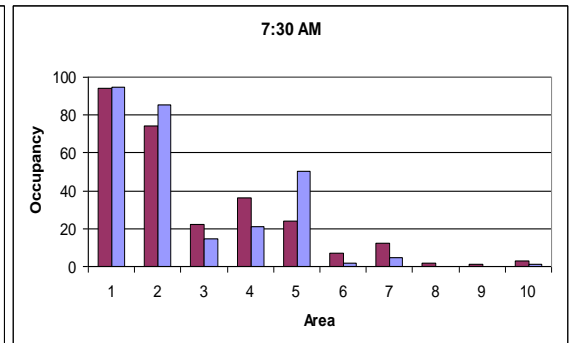
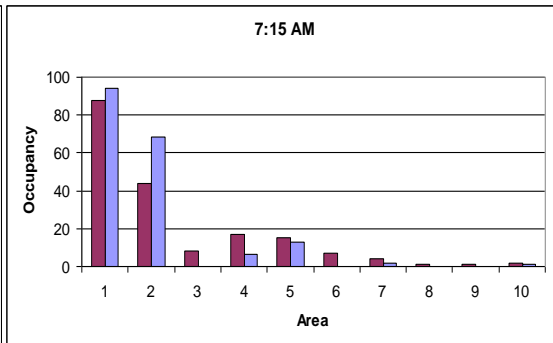
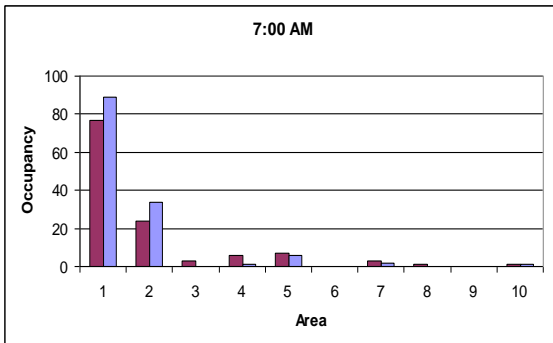
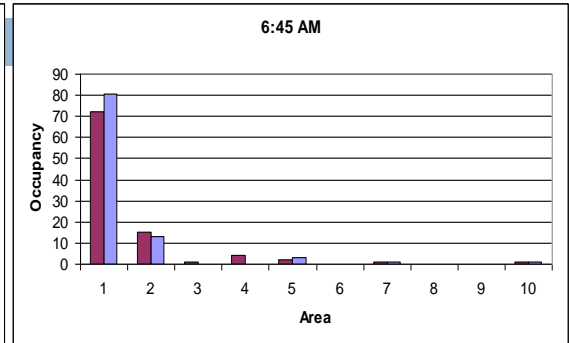
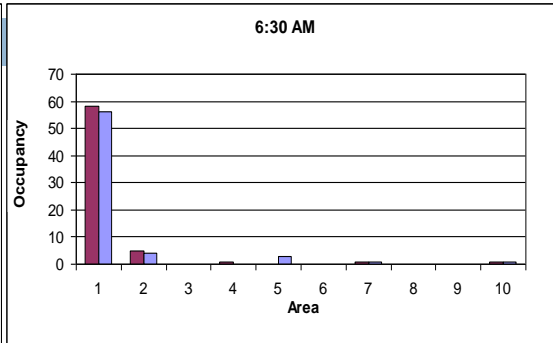
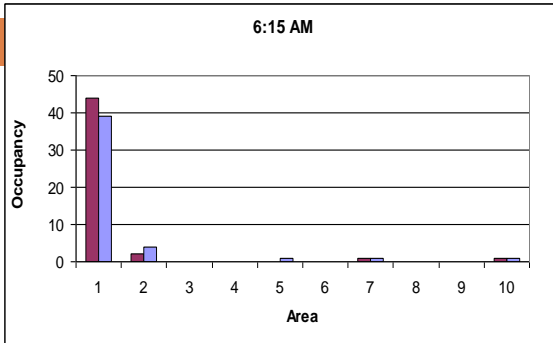


Case Study of Kipling South Lot



Parking Lot Occupation Pattern

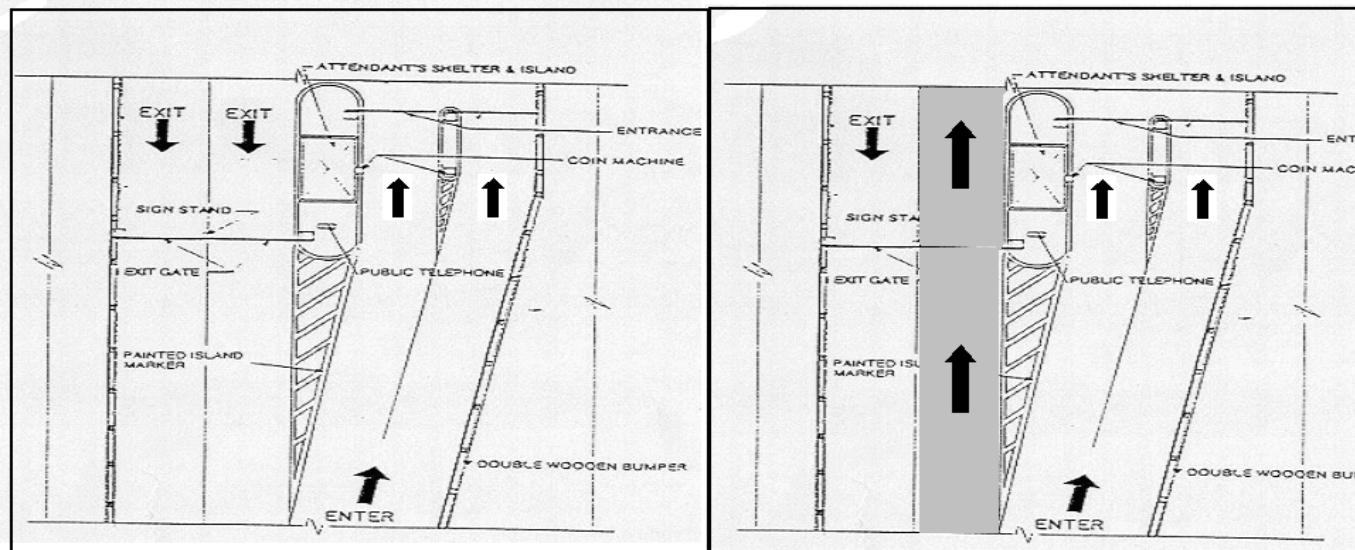
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OBSERVED
 SIMULATION

Assessment of Entrance Modification

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existing design

proposed design

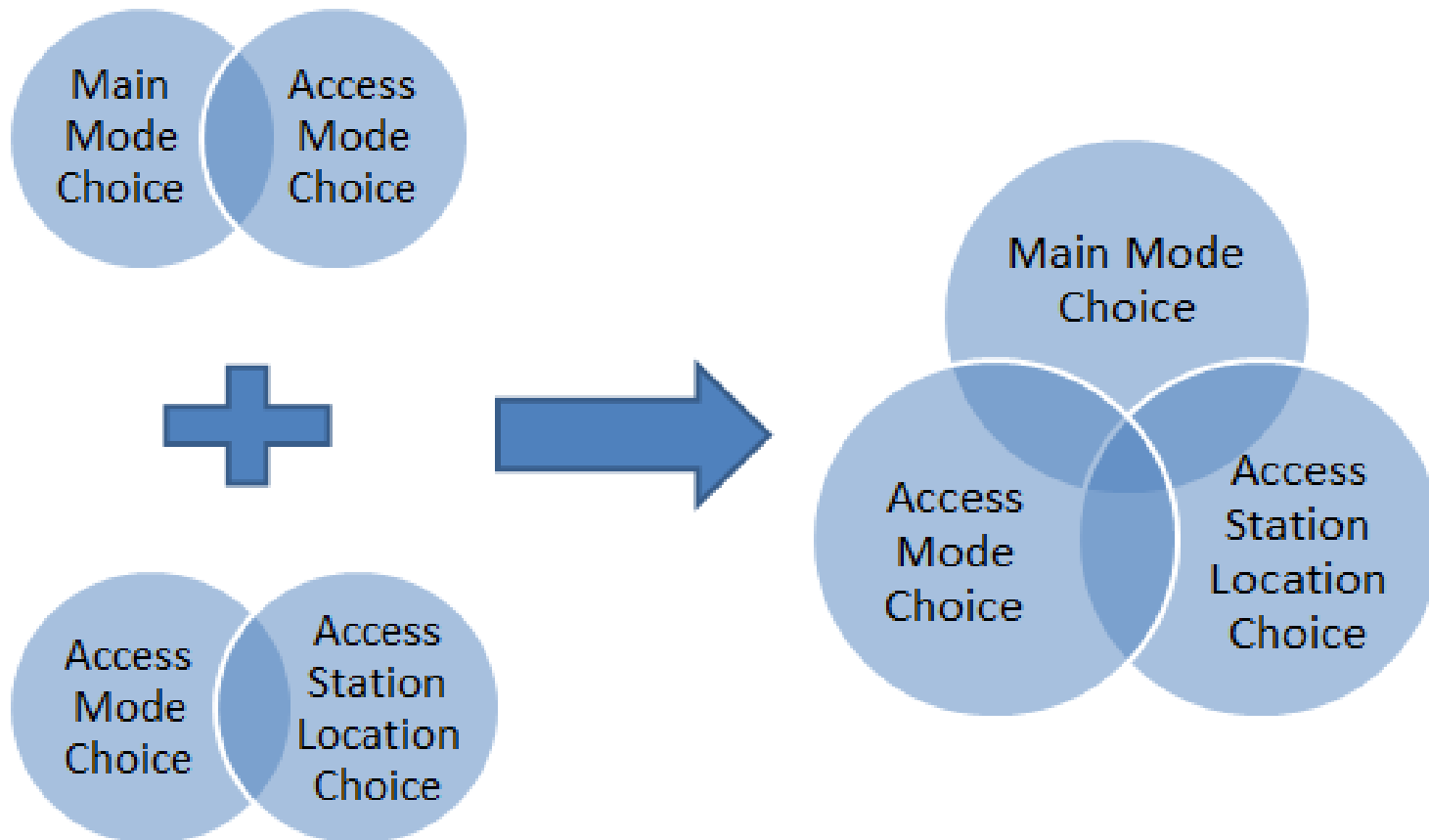
- Improvement in queue times at the lot entrance by 37%

Transfer Station Dynamics

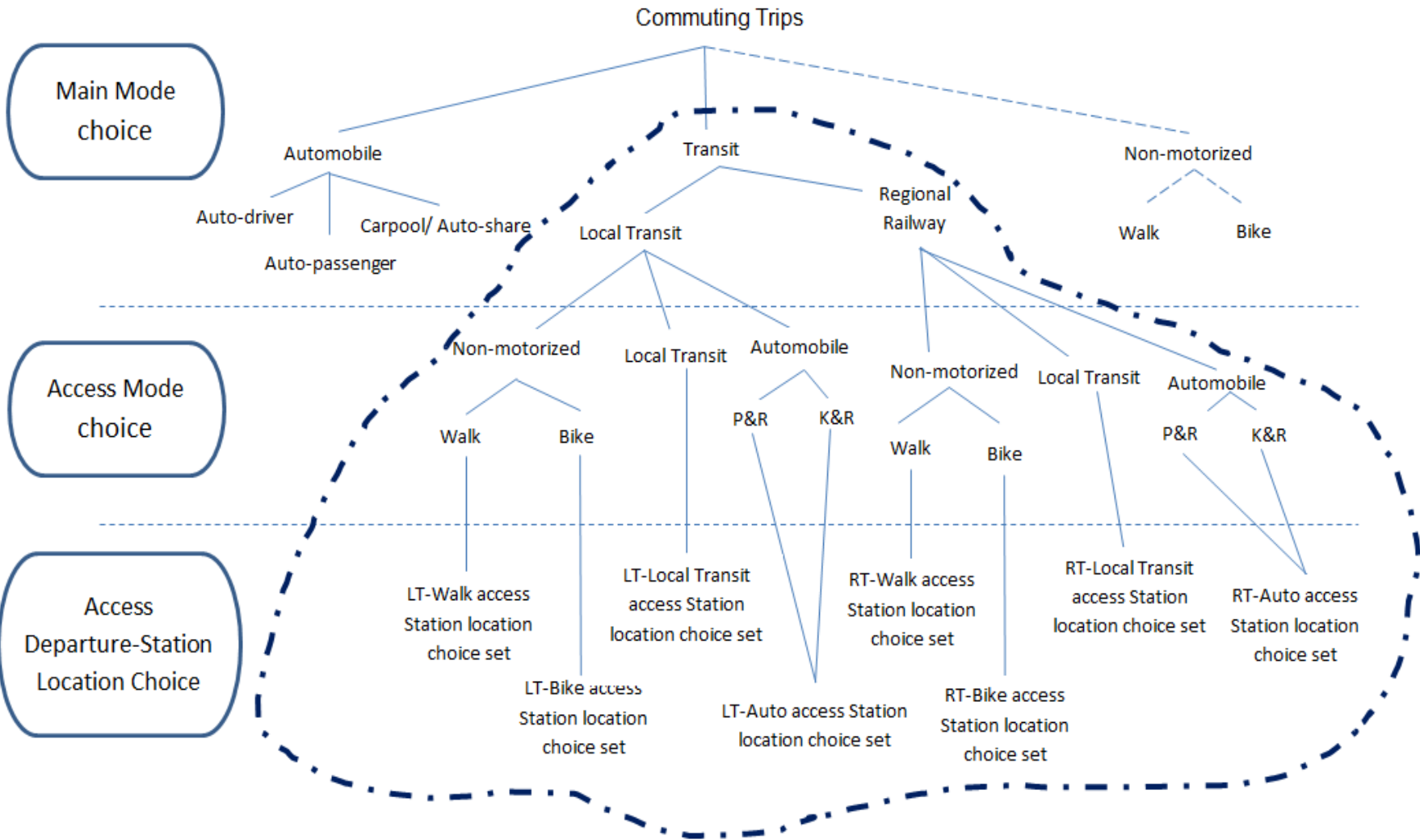
Integrated Crowd and Train Simulation

- Project sponsored partially by an NSERC ENGAGE grant in collaboration with ARUP Canada (includes a summer student supported by the NSERC USRA program)
- Short term objective is to enhance ARUP's MassMotion ability to simulate vertical crowd movements in major transit terminals
- Longer term objective is to develop a flexible and scalable framework to allow for network wide analysis of crowd movement through transit networks
- Analysis of delay propagation based on high congestion and unexpected disruptions

Enhanced Mode Choice Modelling of Inter-Regional Trips



Enhanced Mode Choice Modelling of Inter-Regional Trips



MILATRAS



- MILATRAS: Microsimulation Learning-based Approach to TRansit Assignment
- MILATRAS is a new transit assignment model designed to support modern transit planning

MILATRAS

- Transit assignment backgrounder
 - ▣ Transit assignment is a procedure that assigns an Origin-Destination trip table to the transit network
 - ▣ TA's main output is passenger volumes on individual transit lines and routes
 - ▣ Transit assignment models are useful for both service planning and long-range planning

MILATRAS

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- MILATRAS is designed to address the common limitations of existing methods such as
 - ▣ Improper representation of service congestion effects and capacity constraints
 - ▣ Poor representation of dynamic effects (real time, within day, and day-to-day)
 - ▣ Inadequacy for transit systems of medium-to-low frequency services
 - ▣ Poor sensitivity to effects of ITS technologies on passenger behaviour
 - ▣ Poor treatment of stop choice and departure time choice

MILATRAS

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- Microsimulates both the transit network operations and the individual passengers
- Includes a “cognitive” model that represents the evolution of the user’s knowledge and learning of the system through trip experiences over time
- Models stop choice, path choice and departure time choice simultaneously using learning-based techniques
- Built on an integrated microsimulation and GIS platform
- Detailed outputs at the network, route, run, stop and passenger levels
- Suitable for assessment and design of modern transit systems and ITS technologies
- Easier to explain results to stakeholders