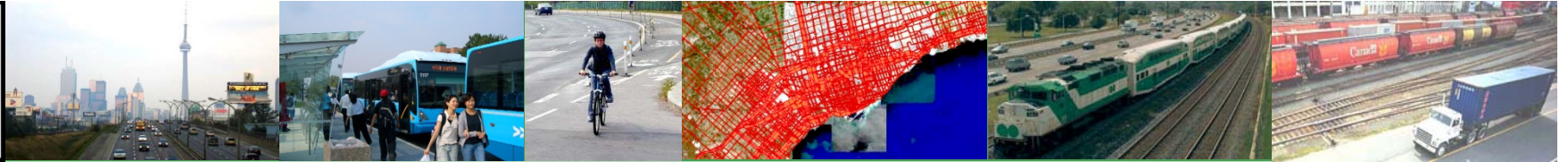


Modelling Transportation in the Greater Golden Horseshoe: Lessons and Challenges

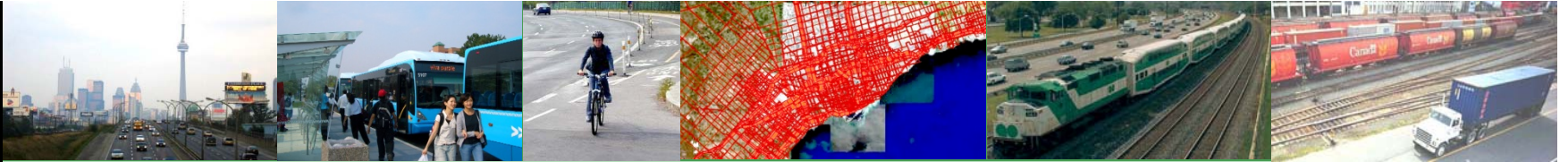
Jesse Coleman, IBI Group

Ontario EMME Users Group Spring Meeting
Toronto, Ontario
May 16, 2008



Outline

- GGH Model project overview
- Model structure
 - Tours and journeys
 - Land use
 - Networks
 - Model process & four stages
- Model application
- Lessons and challenges



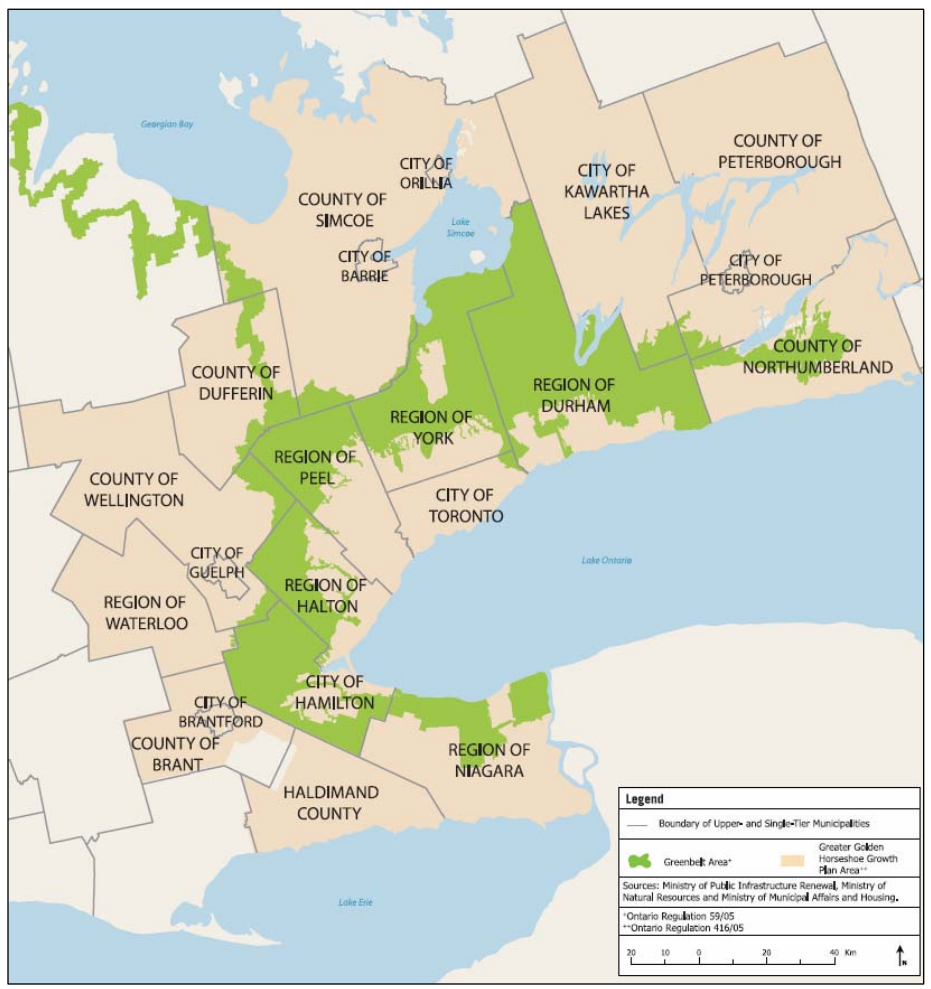
Project Overview

- Goal is to develop transportation and land use forecasting tools for the MTO to be used for all major Ministry planning studies and environmental assessments (EA)
- The model must be sensitive to Growth Plan land use changes and be able to capture the impacts of major public transit investments
- Model is being used as a sketch planning tool in developing the Metrolinx Regional Transportation Plan (RTP) for the Greater Toronto and Hamilton Area (GTHA)



Study Area Overview

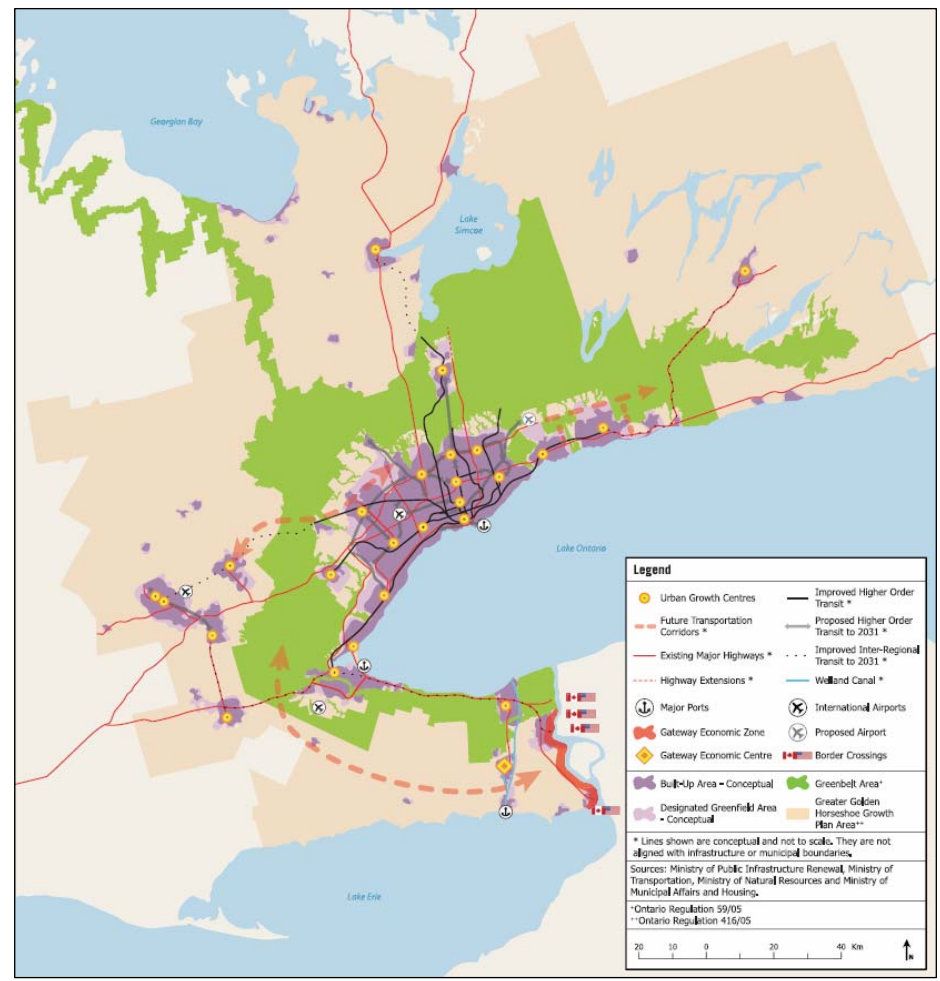
- The Growth Plan for the Greater Golden Horseshoe “Places to Grow” was created as a blueprint on how to accommodate new growth in the GGH.
- Population projected to grow by 48% from 7.79 million in 2001 to 11.5 million in 2031
- Employment projected to grow by 46% from 3.81 million in 2001 to 5.56 million in 2031
- Covers a total land area of 33,400 sq. km.

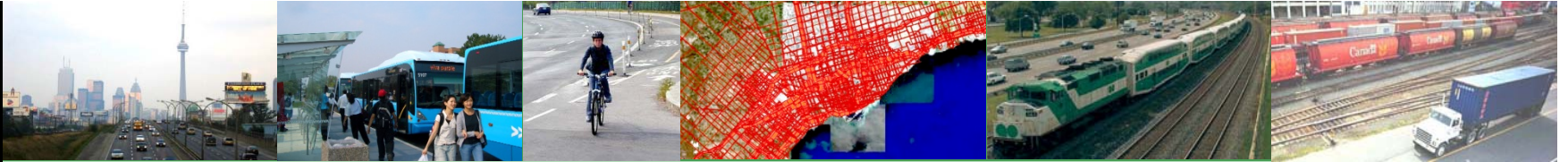




Places to Grow

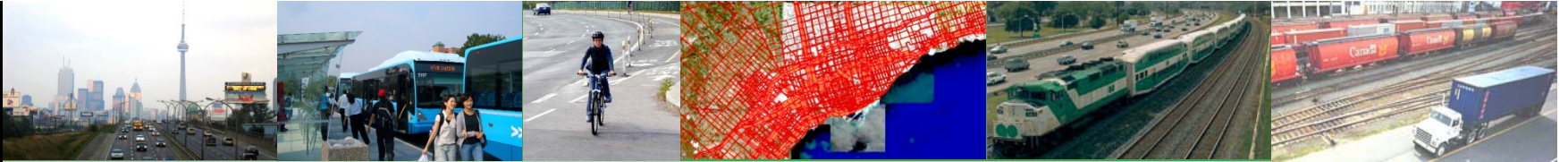
- GGH Model created to be sensitive to changes in land use policies specified in the **Growth Plan**.
- Allocate growth to built up areas where the capacity exists to best accommodate population and employment growth, while providing strict criteria for settlement boundary expansions
- Promote **transit supportive densities** and a healthy mix of residential and employment land uses





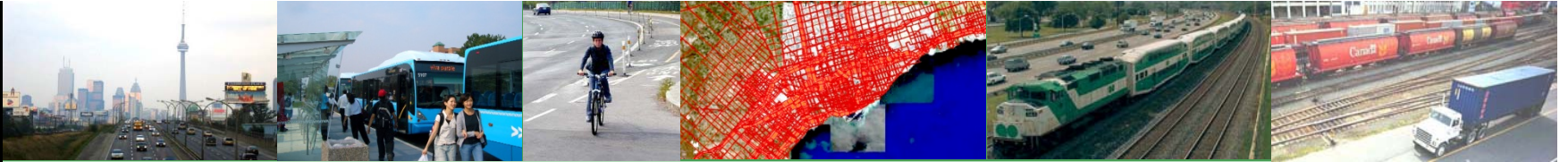
GGH Model Overview

- State-of-practice tour-based a.m. and p.m. peak hour model
- Trips purposes:
 - Home-Work Journeys (HBW)
 - Home-Post Secondary School Journeys (HBPostSec)
 - Home-Elementary / Secondary School Journeys (HBSch)
 - Non Work-School Journeys (NWS)
 - Non-Home Based (NHB)



GGH Model Overview (cont'd)

- Common assumptions/techniques applied throughout the regions allowing projects to be compared on a consistent basis:
 - Population, employment and land use by traffic zone (Growth Plan)
 - Road classification and volume-delay functions
 - Common transportation network assumption for base year and future years
 - Municipalities consulted to obtain most current information available



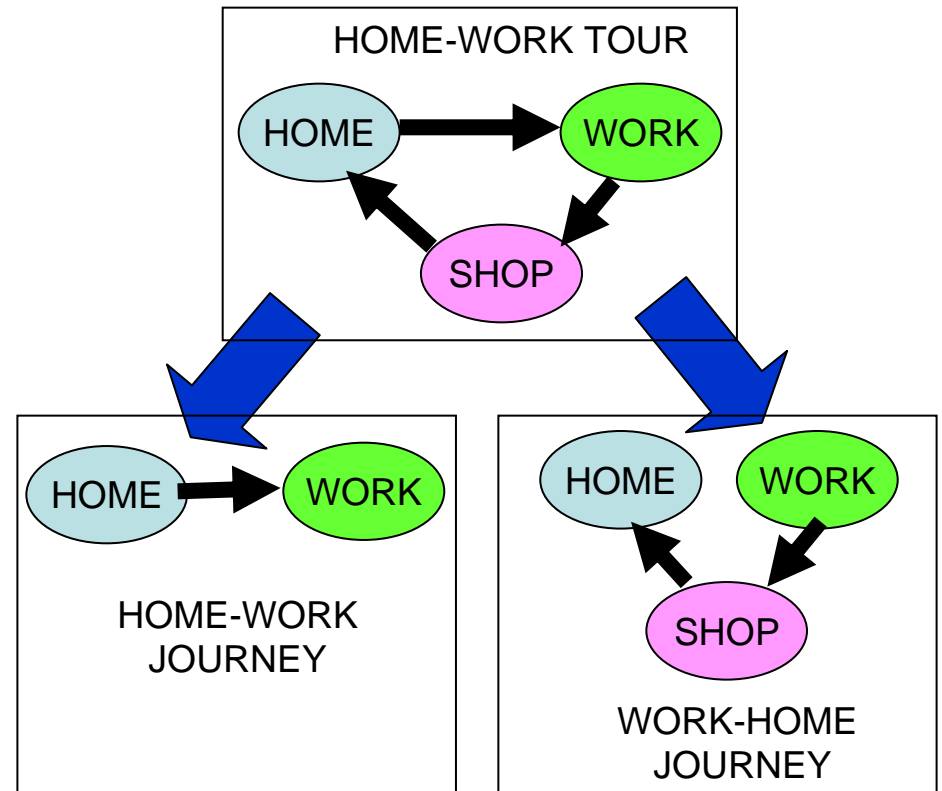
GGH Model Overview (cont'd)

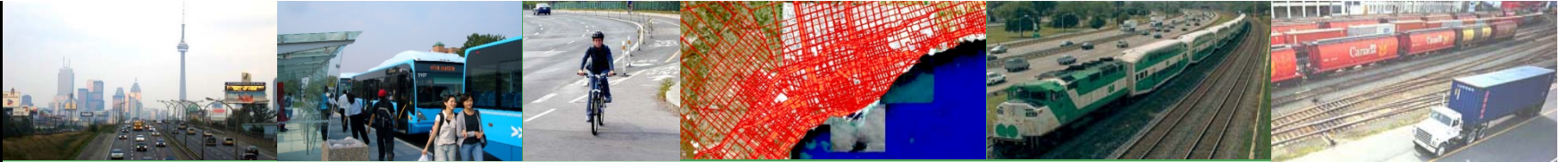
- Ability to test Growth Plan directions and policies, and sustainable transportation modes/initiatives:
 - Socioeconomic/demographic sensitive:
 - Age, job type, household structure, income, auto ownership
 - Level-of-service sensitive:
 - Logit mode choice, gravity trip distribution, equilibrium assignment with feedback mechanisms
 - Land use sensitive:
 - Spatial distribution affects trip length, travel self-containment
 - Land use typology defined for each zone
 - Walk time to transit, road speed/capacity, trip generation differs based on land use



Terminology: Journeys and Tours

- A **tour** is a complete movement leaving home and returning home again
- A **journey** is one half of a tour, which is the movement from the primary origin to the primary destination





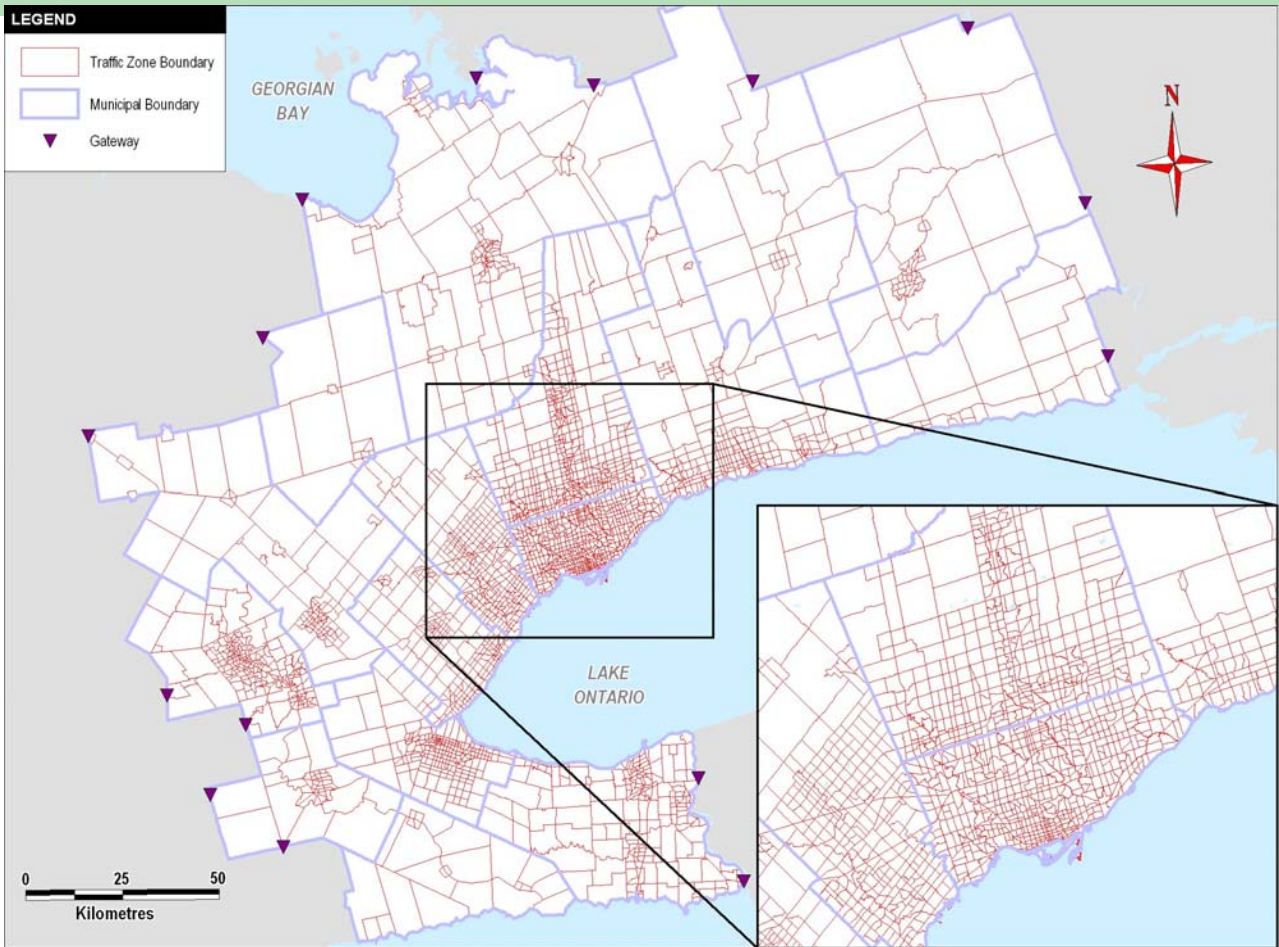
Why tour-based?

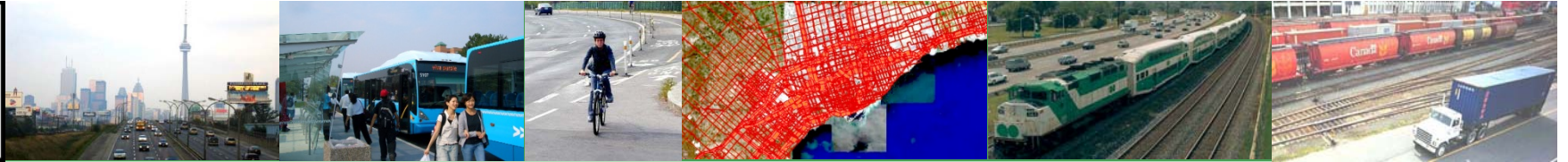
- Focuses analysis on the primary movement that generates the trip (i.e. work or school), while filtering out the noise of relatively unimportant stops within the journey
- As a result, provides significantly more explanatory power relative to conventional trip-based models
- Need to model both a.m. and p.m. peak per
- Can be a precursor to more complex activity-based model systems



GGH Model Traffic Zone System

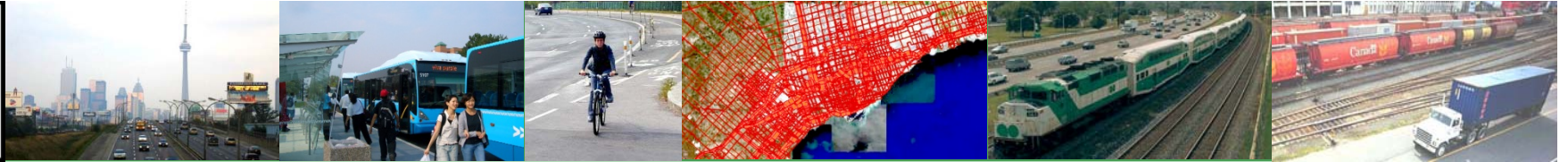
- Approximately 3,000 zones defined for GGH
- Based on municipal, census and transportation (road/rail boundaries), geographic feature, land use, etc.
- Includes representation of urban growth centres





Land Use / Socio-economic Inputs

- For the GGH Model, information and forecasts include:
 - Population
 - Age
 - household structure
 - Employment status
 - Labour force participation by occupation
 - Employment
 - Number of jobs by job category
 - Full time/part-time



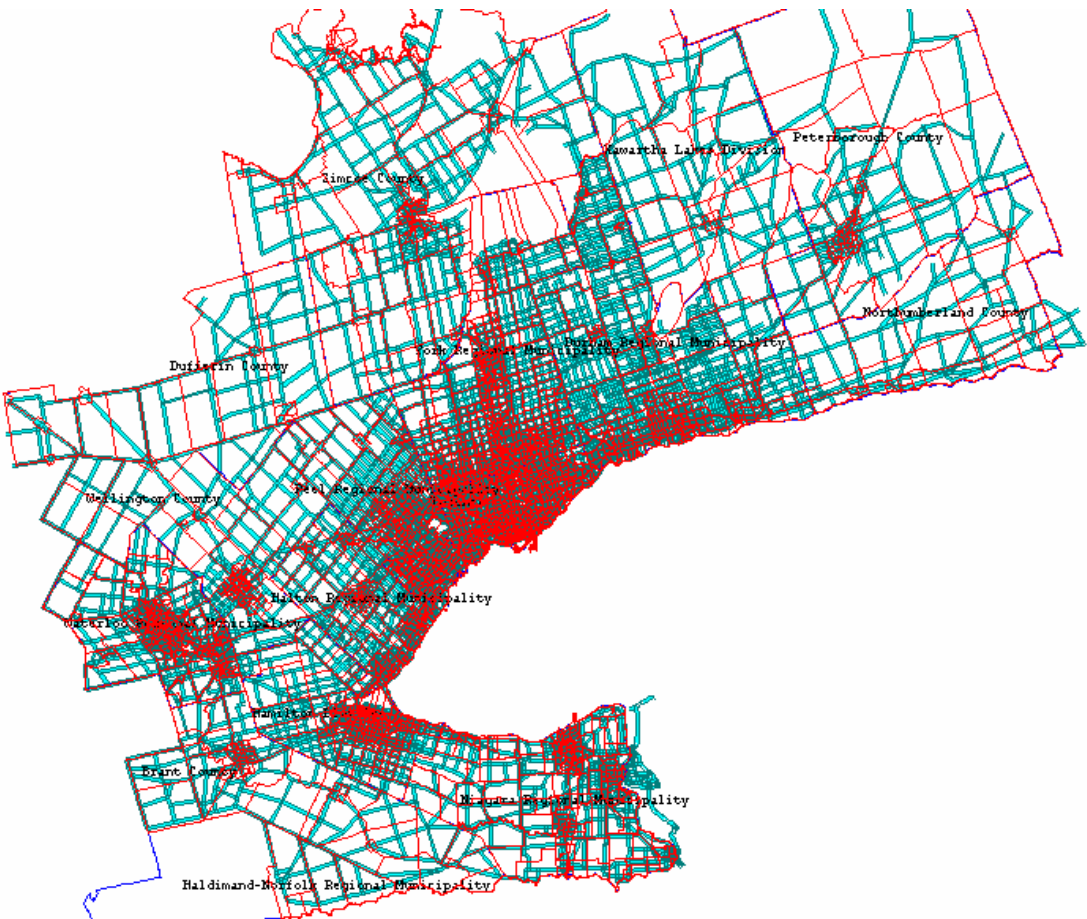
Future Land Use

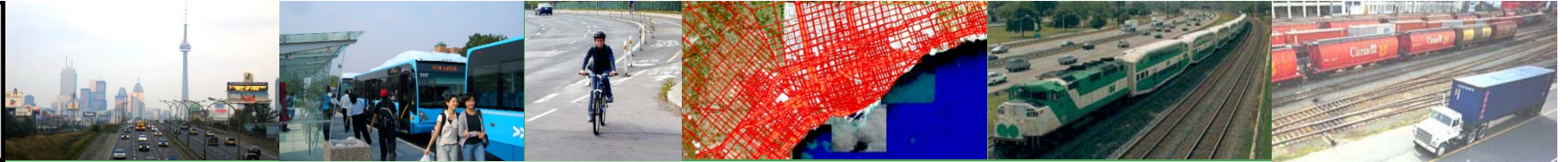
- Detailed to 3,000 traffic zones; corresponds to Growth Plan targets by municipality
- Achieves Growth Plan targets for urban growth centres, built-up areas, designated greenfield areas
- Reflects future trends:
 - Age distribution of the population will change significantly
 - Dwelling preferences changes by age of household
 - Growth Plan imposed shifts in structural types permitted
 - Employed by industry mix will change significantly



Road Networks

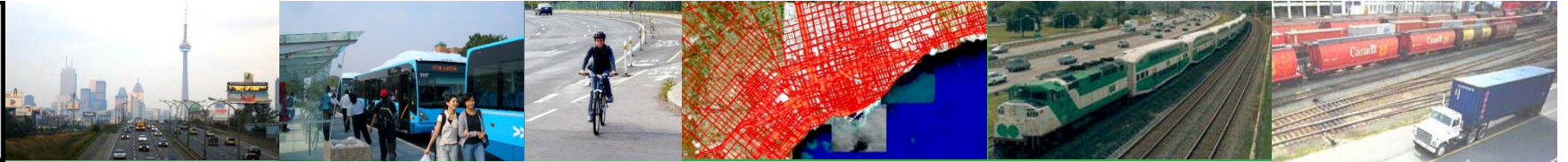
- Network coding standards revised/enhanced and consistently applied across GGH
 - Consistent with DMG standards and linked to functional class, area type and adjacent land use
 - More accurate speed and capacity representation
- Calibration of volume-delay functions
- 18,000 regular nodes and 64,000 links





Transit Networks

- Improved estimation of walk access times
 - Eliminate zone size bias
 - Based on land use / street layout
- Enhanced transit time function
 - Sensitive to traffic congestion; no longer fixed constant speed over entire length of route
 - Estimated as a function of auto travel time, number of stops and dwell time
- 1450 one-way transit lines with 42,000 segments

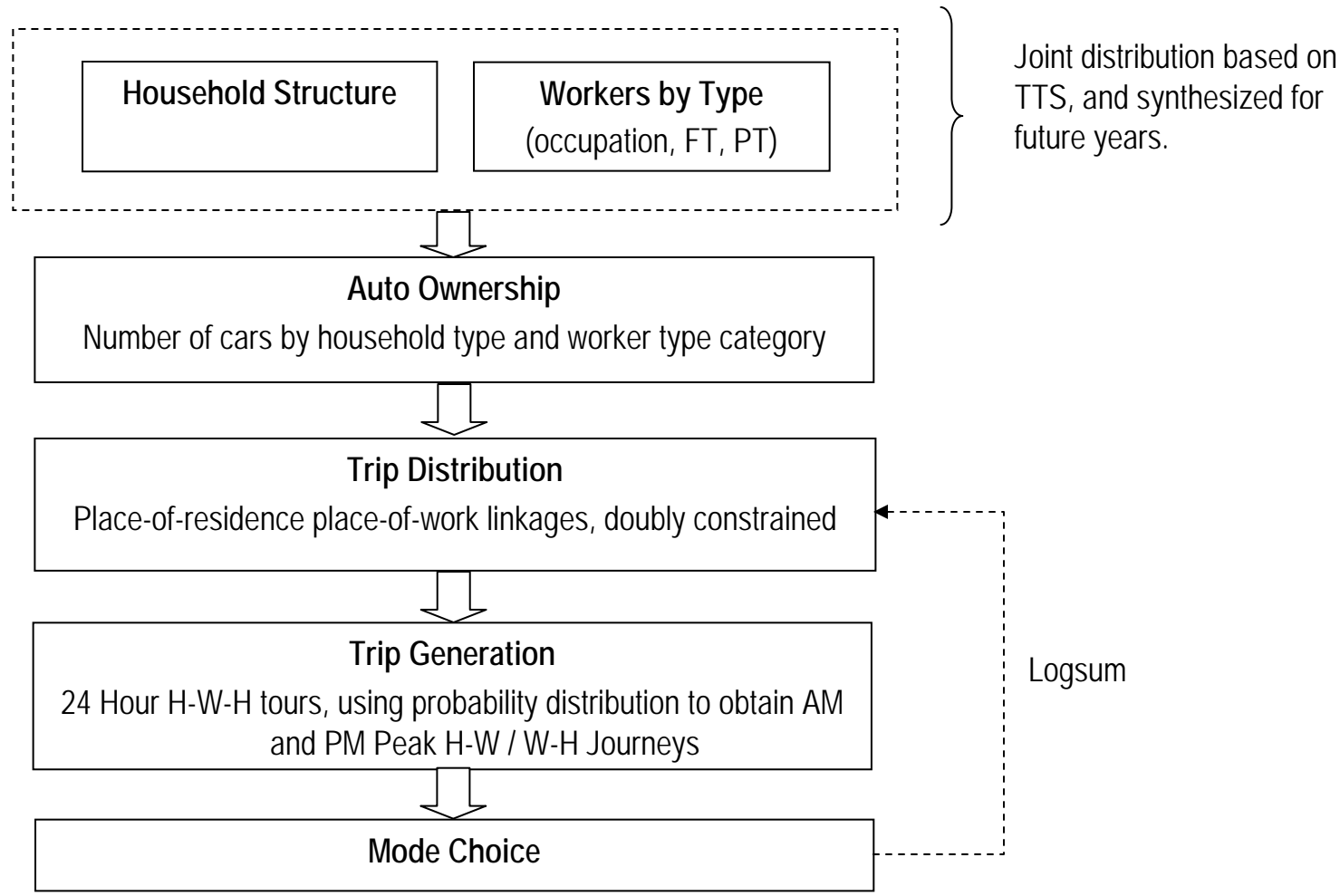


Model Process

- Trip Generation & Auto Ownership:
 - Trip rates or regression equations by purpose with segmentations by household structure, job type, auto ownership
- Trip Distribution
 - Gravity model segmented by occupation (4 categories)
 - Log-sum based on utilities of logit model
- Model Split
 - Nested logit model
- Trip assignment
 - User equilibrium

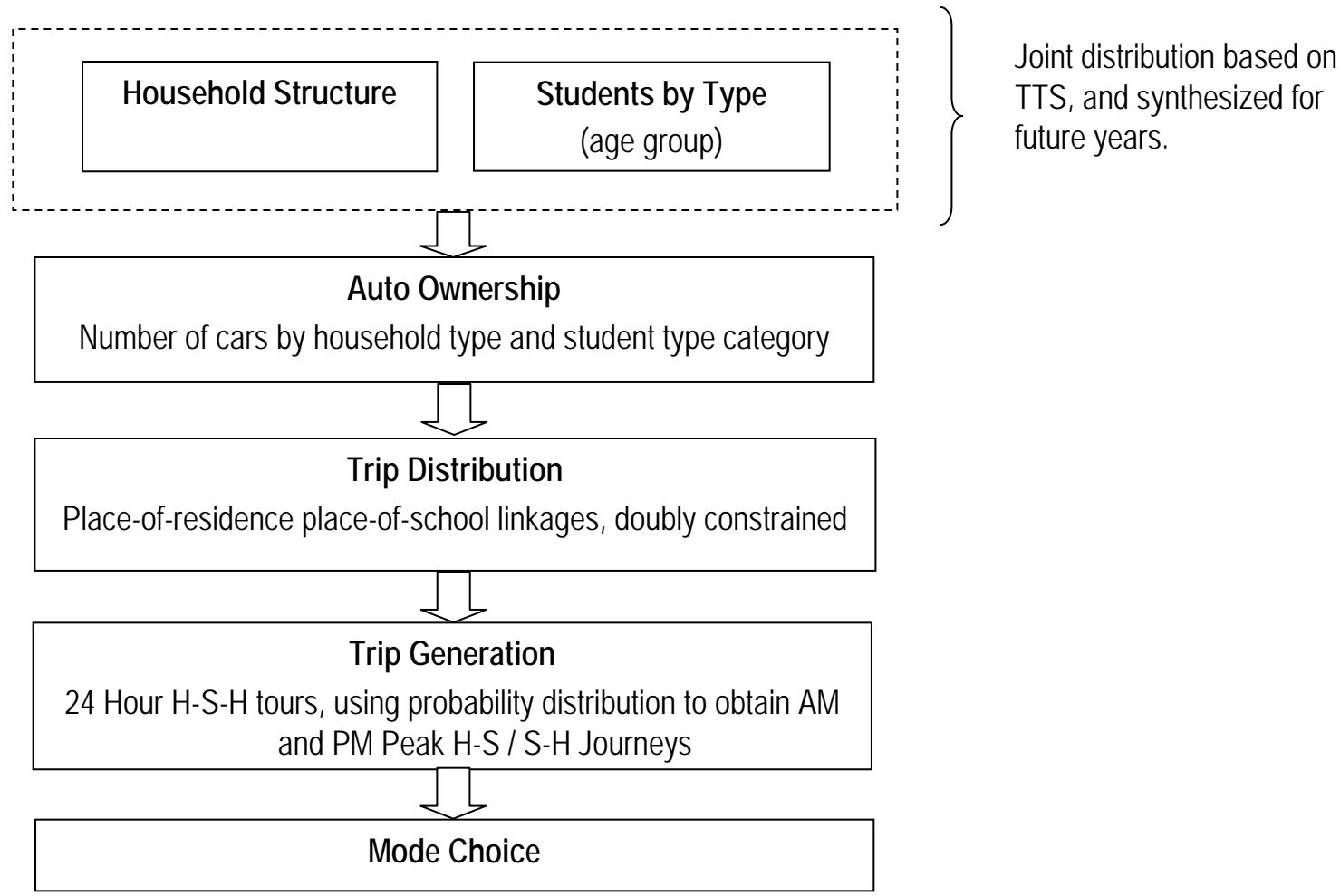


Home-Work Model Sub-system



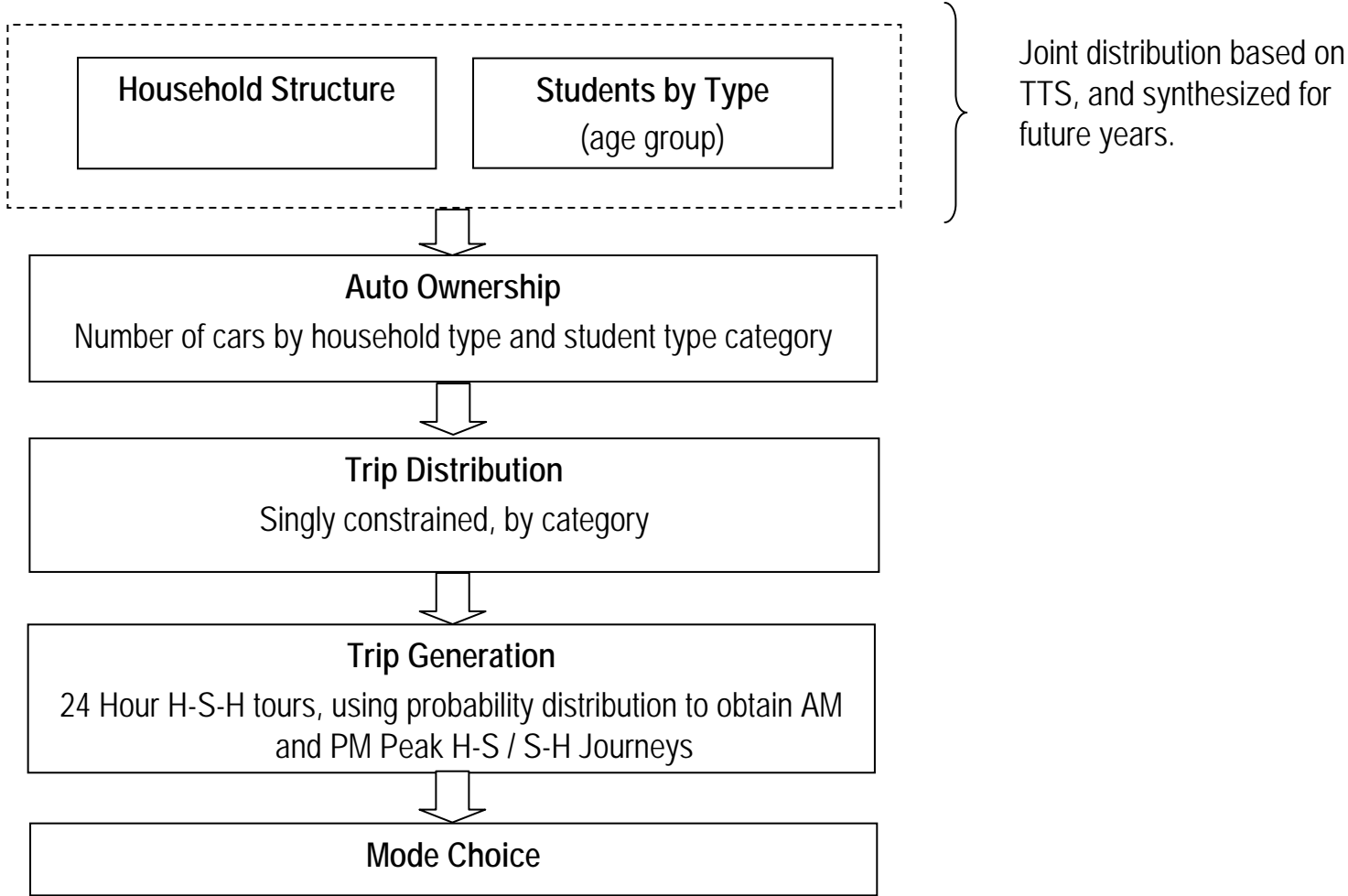


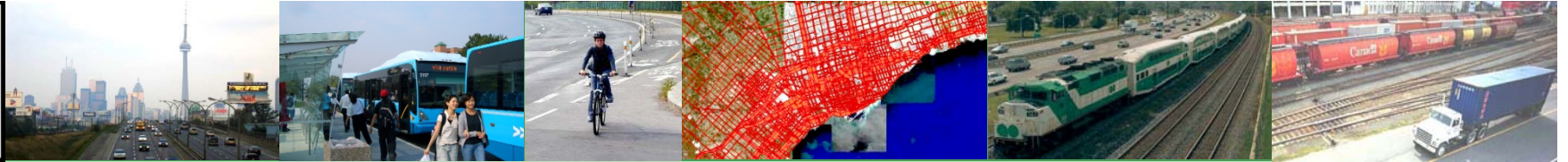
Home-PostSecSchool Model Sub-System





Home-School Journey Model Sub-System

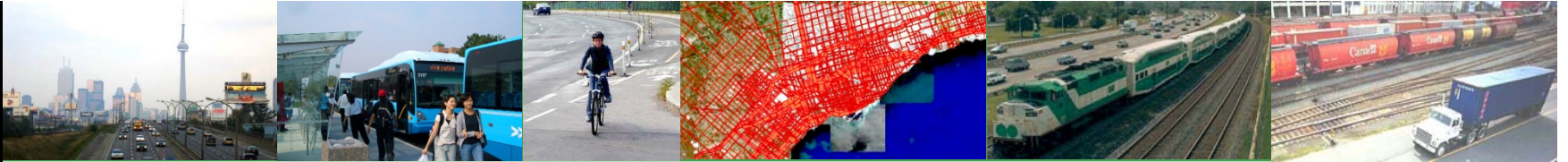




Linkage & Journey Generation

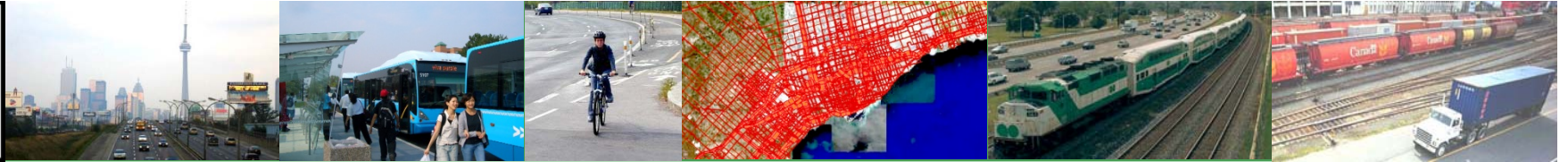
2 Step process:

- Daily linkages generated by household type (i.e single parent or two parent 3 child households), person type (i.e. worker/student, full time/part time) & auto ownership segment.
- After trip distribution is complete, the daily linkages are factored to become daily tours that occur within one or both peak periods
- After mode choice is complete, the daily tours are factored to become a.m. and p.m. peak period journeys



Linkage Distribution

- Work purposes
 - Gravity model segmented by occupation (4 categories)
 - Impedence from mode choice logit model Log-sum
- Secondary School
 - Gravity model using same logsum term as the work model
- Elementary & Secondary Schhol
 - Singly constrained logit destination choice models
- Other, Shopping & Non Home Based
 - Trip-based approach, using a fratar distribution

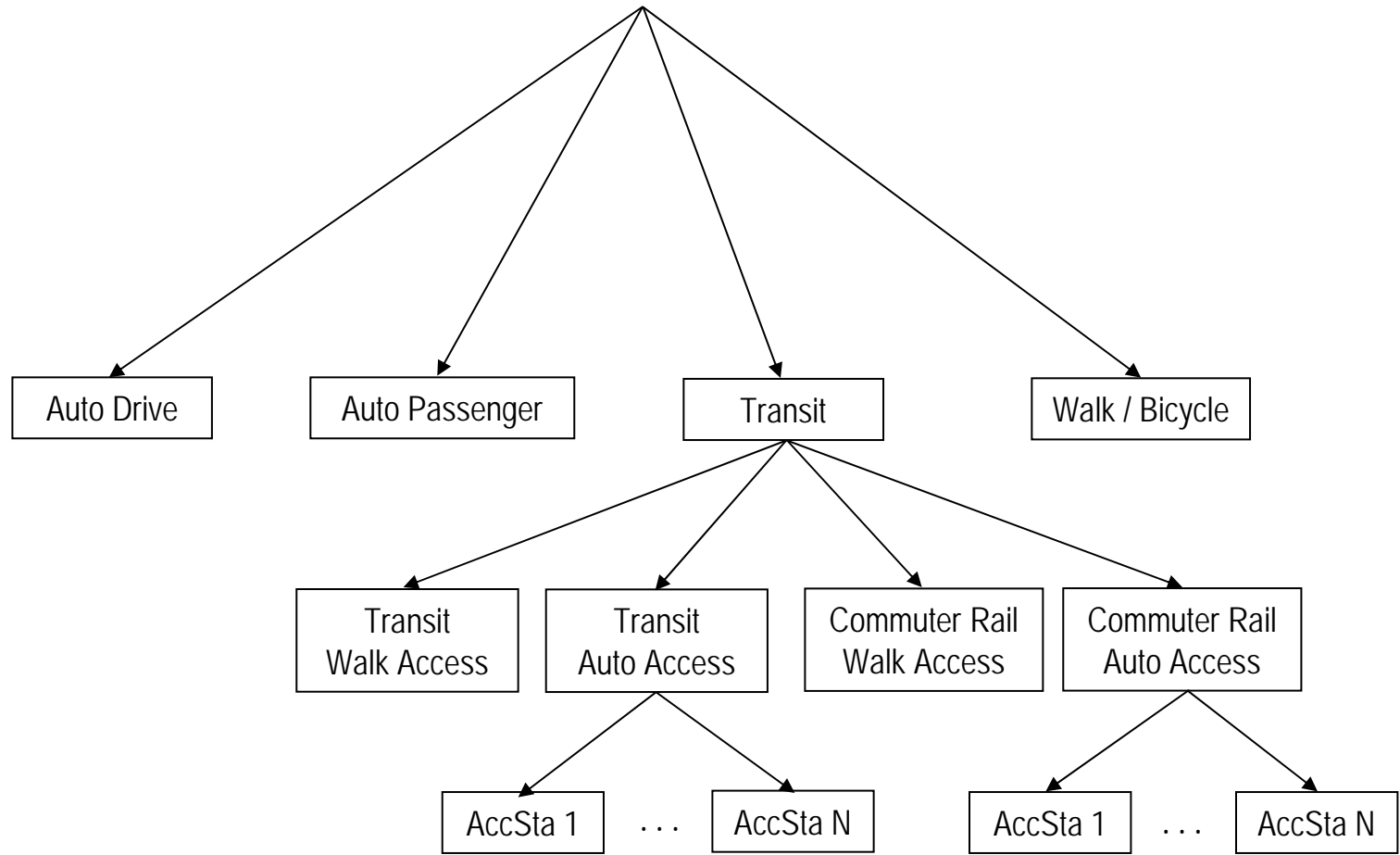


Mode Choice

- Models the home-destination-home tour holistically as a joint mode choice across the two time periods, using service levels for the two peak periods in an integrated manner.
- Nested logit model for work and post-secondary school purposes
- Multinomial logit models for other purposes
- Range of level of service and spatial/land use variables are included to maximize explanatory power and sensitivity
- Park and ride station choice model

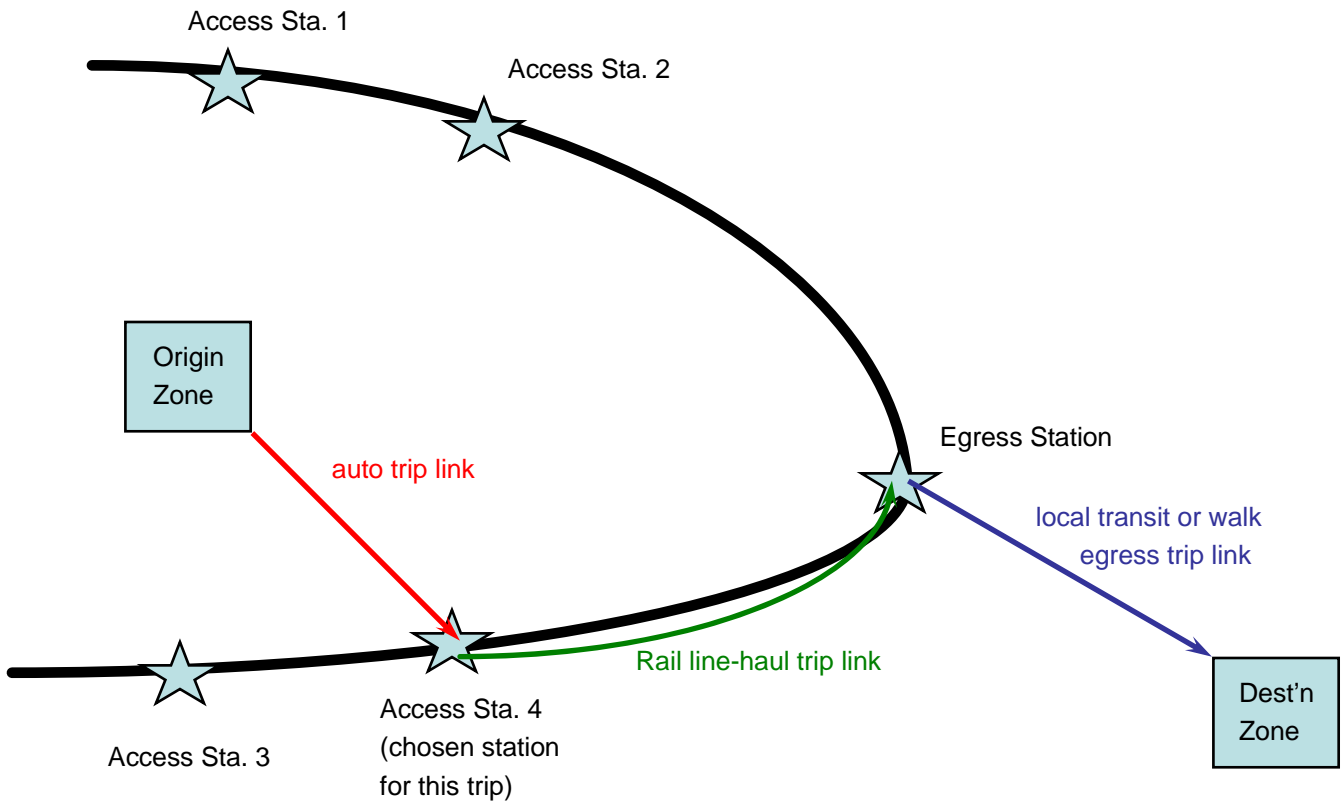


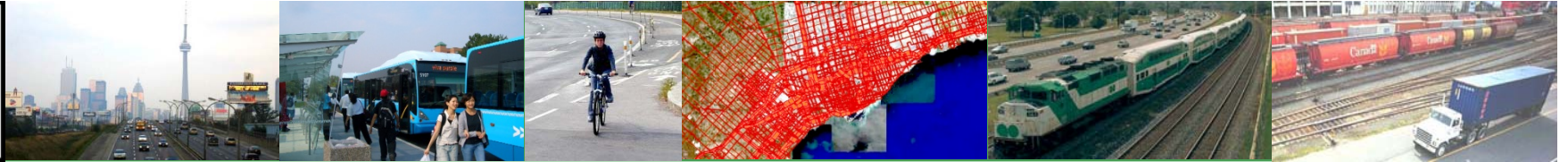
Work Tour Mode Choice





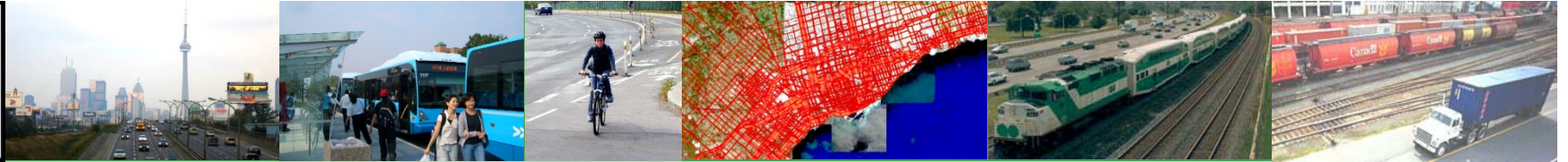
Park and Ride Station Choice





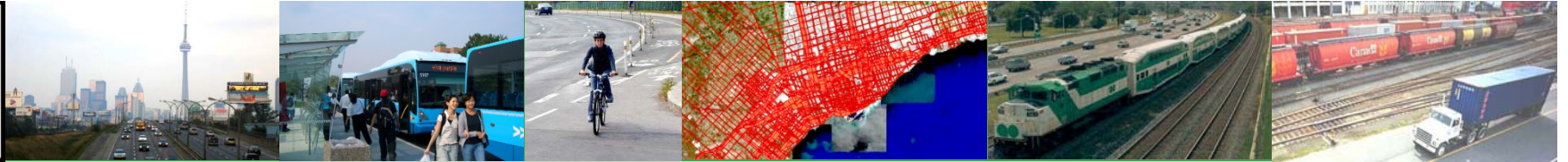
Trip Assignment

- EMME user equilibrium auto and transit assignments
- Matrix convolution used to assign auto and transit portions of park and ride trips to/from the chosen station.
- Future integration with commercial vehicle model, running PCE assignments.



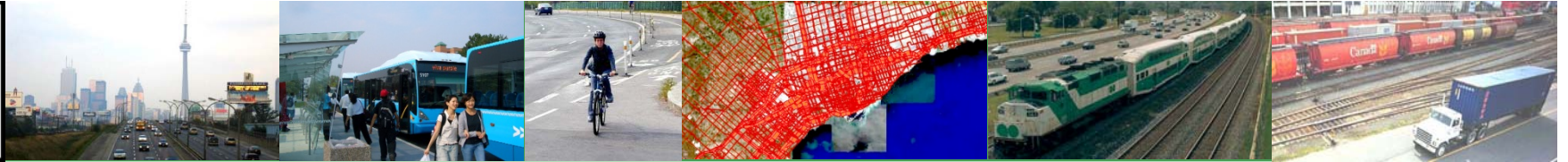
Model Application

- Implemented entirely in EMME using macros/scripts
- Travel times averaged between cycles to aid convergence
- 4.8 GB databank
 - 2 scenarios (a.m. & p.m. road and transit integrated networks) + 2 working copies
 - 135 full matrices, 999 mo vectors
- Four-stage full model runs converge after 4 cycles, each taking ~7 hours (~28 hours total)



Lessons and Challenges

- Model very complex, resulting in very long cycle times (6-7 hours).
- 7 hour cycle times means that models can no longer be run overnight
- Investigating ways of freezing certain model elements to test minor network changes without needing a full model run (i.e freezing trip distribution)
- Tour based mode choice approach computationally intensive as both a.m. and p.m. matrices need to be stored concurrently. Is this gain in explanatory power worth the computational burden?
 - Looking into methods to run the model on one time period only as an option to save time



Question for INRO?

- As regional models become increasingly complex, what steps are INRO planning to keep computational demands under control:
 - Support for multicore processors, or parallel computing?
 - Other ideas?