# Space-Time Traffic Assignment

**Bryce Sharman** 

DTA Applications in the GTHA University of Toronto

March. 13<sup>th</sup>, 2019







#### Static Assignment Review

- Primary Simplifications
  - Vehicle interactions not considered, mathematical representation of delay
  - All trips span from origin to destination
- Advantages
  - Well studied, stable results, relatively easy to calibrate
- Drawbacks
  - Cannot profile start times in the assignment
  - Trips span from origin to destination (examples):
    - 1-hour assignment: Trip from Hamilton to Oshawa
    - 3-hour assignment: short trips always on the network



## STTA: What, and why?

#### What:

- Divides the time period and demand into intervals.
- Link flows/analysis results have discrete time component
   Why:
- Large study areas (regional, provincial, national)
  - Long trips are present
  - Trips profiled (segmented) into time periods
- Very useful to produce time-profiled subareas

Uses same network, volume delay functions, etc. as other Emme traffic assignments!



## Example

# Barrie to University of Toronto

SOTA asistig Manhemutr intervals



vsp

## Two-Level Algorithm

- Internally duplicates network for each time interval
- Two-level problem:
  - 1. Outer loop
    - Defines subnetwork for each path (determines where paths switch between time intervals)
  - 2. Inner loop
    - Converges subnetwork using SOLA algorithm

# Setting up an STTA Run



## Define time periods

- *Start time* is just for reporting
- Can have unequal time periods
- Extra periods to clear the network
- Optional variable background traffic and network topology

RINI	R 🗋 - Emme Standard - Traffic assignment
	Space-time traffic assignment
Performs space-time tra	affic assignments with multiple classes, generalized cost, or path analysis.
<ul> <li>Image: Second system</li> <li>Image: Assignment period</li> </ul>	e traffic assignment specification
Start time: Interval lengths (4 intervals, max 125): Extra time interval: Number of extra time intervals (max 122):	07:00 30 repeat 4 30 2
> 2. Background traffic	
3. Variable topology	
> 4. Traffic classes	
> 5. Default analysis	
> 6. Per-class analysis	
7. Results	
8. Stopping criteria	

## Time varying attributes / matrices

- STTA still uses EMME database structure
- Inputs/outputs use *time varying attributes* 
  - Example: 1 class, 3 intervals
    - Input demand matrix: mf10
      - Interval 1: mf10
      - Interval 2: mf11
      - Interval 3: mf12
    - Input link volumes: @volau\_1
      - Interval 1: @volau\_1
      - Interval 2: @volau\_2
      - Interval 3: @volau\_3



## Traffic Classes

- Similar to other Emme traffic assignments
- Time varying attributes/matrices
  - Demand
  - Generalized costs
  - Results
- Demand defined as flow rate (veh/hr)<sup>1</sup>

Space-time traffic assignments with multiple classes, generalized cost, or path analysis.   Performs space-time traffic assignment specification (modified) I Assignment period 2. Background traffic 3. Variable topology 4. Traffic classes   Mode:   0: mode i   i HOV3+   Demand:   mf170 (demo_matrix_0),P   Generalized Cost   Link costs:   O- D fixed cost:   Results   Save link volumes:   Save link volumes:   Save vehicle count at destinations:			
Performs space- time traffic assignments with multiple classes, generalized cost, or path analysis.		Space-time traffic assignment	
Performs space-time traffic assignments with multiple classes, generalized cost, or path analysis.			
Unsaved space-time traffic assignment specification (modified) 1. Assignment period 2. Background traffic 3. Variable topology 4. Traffic classes   0: mode i + Add a class   Mode:  i HOV3+     Demand: mf170 (demo_matrix_0),P   Generalized Cost  I    Link costs:    0- D fixed cost:   Results   Save link volumes:   Save link volumes:   Save urn volumes:   Save urn volumes:   Save urn volumes:   Save urn volumes:   Co not save   Do not save   Do not save	Performs space-time	analysis.	generalized cost, or path
Unsaved space-time traffic assignment specification (modified) 1. Assignment period 2. Background traffic 3. Variable topology 4. Traffic classes   Mode:  (mode i * + Add a class)    Mode:  (mf170 (demo_matrix_0),)    Demand:  (mf170 (demo_matrix_0),)    Generalized Cost  Intro (demo_matrix_0),)    Link costs:  O: not save     O-D fixed cost:  Do not save     Results    Save link volumes:   Save turn volumes:   Save vehicle count at destinations:			
Image: Construction (modified)         1. Assignment period         2. Background traffic         3. Variable topology         4. Traffic classes         Mode:         Demand:         Generalized Cost         Link costs:         O-D fixed cost:         Results         Save timk volumes:         Save timk volumes:         Save turn volumes:         Save vehicle count at destinations:         Vont save         Do not save         Do not save         Do not save         Save turn volumes:         Save vehicle count at destinations:			
1. Assignment period         2. Background traffic         3. Variable topology         4. Traffic classes         Mode:         Demand:         iHOV3+         mf170 (demo_matrix_0)         Generalized Cost         Link costs:         O-D fixed cost:         Results         Save link volumes:         Save turn volumes:         Save vehicle count at destinations:         Von not save         Do not save         Do not save         O- Do fixed count at destinations:	Unsaved space	time traffic assignment specification (modified)	
2. Background traffic 3. Variable topology 4. Traffic classes Mode: Demand: Demand: Generalized Cost Link costs: O-D fixed cost: Results Save link volumes: Save un volumes: Save vehicle count at destinations: Do not save P Do not save P Do not save P C	1. Assignment period		
3. Variable topology 4. Traffic classes Mode: Demand: Demand: Generalized Cost Link costs: O-D fixed cost: Results Save link volumes: Save turn volumes: Save vehicle count at destinations: E. Default analyzis	2. Background traffic		
4. Traffic classes         Mode:	3. Variable topology		
0: mode i       x       + Add a class         Mode:       i HOV3+       p         Demand:       mf170 (demo_matrix_0)       p         Generalized Cost       I         Link costs:       I         O-D fixed cost:       I         Results       Do not save       p         Save link volumes:       Do not save       p         Save vehicle count at destinations:       I       I	4. Traffic classes		
0: mode i   Mode:   i HOV3+   Demand:   mf170 (demo_matrix_0)   Generalized Cost   Link costs:   0-D fixed cost:   Results   Save link volumes:   Do not save   Save turn volumes:   Do not save   Save vehicle count at destinations:		asels a bbA t	
Mode:     I HOU3+     P       Demand:     mf170 (demo_matrix_0) P       Generalized Cost     I       Link costs:     I       0-D fixed cost:     I       Results     I       Save link volumes:     Do not save       Save turn volumes:     Do not save       Save vehicle count at destinations:     I		0: mode i	
Demand:     mt1/0 (demo_matrix_0, p)       Generalized Cost	Mode:		
Generalized Cost     L       Link costs:        O-D fixed cost:        Results        Save link volumes:     Do not save       Save turn volumes:     Do not save       Save vehicle count at destinations:	Demand:	m170 (demo_matrix_0),p	
Link costs: O-D fixed cost: Results Save link volumes: Save turn volumes: Save vehicle count at destinations: Conot save P Do not save P Conot save P	Generalized Cost		
O-D fixed cost:  Results Save link volumes: Save vehicle count at destinations:  Do not save C	Link costs:		
Results     Do not save     Do       Save link volumes:     Do not save     Do       Save turn volumes:     Do not save     Do       Save vehicle count at destinations:     Do not save     Do	O-D fixed cost:		
Save link volumes: Save turn volumes: Save vehicle count at destinations: Do not save P Do not save P Cont save P	Results		
Save turn volumes: Save vehicle count at destinations: 5. Default analysis	Save link volumes:	Do not save	
destinations:     Do not save     P	Save turn volumes: Save vehicle count at		
5 Default analysis	destinations:		
E. Default analysis		<	2
5. Default analysis	5. Default analysis		
6. Per-class analysis	6. Per-class analysis		
7. Results	7. Results		
8. Stopping criteria	8. Stopping criteria		

1. Or time unit in your vdfs.

## Results

- Link/turn volumes (flow rates in veh/hr)<sup>1</sup>
- OD travel times
- Analyses ... :
  - Select link
  - Distance
  - Traversal

	Space-time traffic assignment	
Performs space-time tra	ffic assignments with multiple classes, generalized cost, or path analysis.	
Dusaved space-time	traffic assignment specification	
1. Assignment period		
2. Background traffic		
3. Variable topology		
4. Traffic classes		
5. Default analysis		
6. Per-class analysis		
7. Results		
Link volumes:	@link_volumes_per_1 - P	
Link costs:	Do not save	
Turn volumes:	Do not save	
Turn costs:	Do not save	
O-D travel time shortest paths:	Do not save	

1. Or time unit in your vdfs.



## Stopping Criteria

- Two-level problem
- Outer problem
  - Number of iterations
  - 20 is a reasonable default but experimentation required
- Inner problem
  - Same as other traffic assignments
  - Shouldn't stop on number of inner iterations criteria.
- Can be parallelized to improve run times.

	Space-time t	traffic assignment
Performs space-time t	raffic assignments a	with multiple classes, generalized cost, or path analysis.
<ul> <li>Unsaved space-tir</li> </ul>	ne traffic assignment :	specification
1. Assignment period		
2. Background traffic		
3. Variable topology		
4. Traffic classes		
5. Default analysis		
6 Per-class analysis		
7. Results		
8. Stopping criteria		
Maximum outer iterations:	20	
Maximum inner iterations:	1000	
Normalized gap:	0	
Relative gap		
Coarse:	0.001	
Fine:	0.0001	
Best relative gap		
Coarse:	0	%
Fine:	0	%

## Gotchas

#### Blackholes

- All traffic must be able to exit a link during a time interval – otherwise trapped
- Check link lengths
- Can adjust VDFs
- Verify using cost result attributes
- Tolling
  - Be careful response to generalized costs not the same as other traffic assignments
  - INRO says that this should be improved in Emme 4.4



#### **TRESO Example project**

**09**:00 - **08**:59

- Provincial multimodal model, passenger and freight for MTO
- Network spans continental North America
- 6,638 zones
- 160,000 road links
- 9 traffic classes
- 10 time intervals



#### Recap

- STTA is an extension of 'traditional' Emme traffic assignments that adds a time component
- Allows:
  - Time profiled start times
  - Long trips to be broken up into different periods
  - Short trips only present during single period
- Expands network (internally) across time periods
- Time-varying inputs and outputs for time profiles

#### STTA vs. DTA

- STTA is still based on a 'macro model' philosophy
  - Individual vehicles not modelled
  - Delays based on mathematical formulations
  - Simplified (Emme-based) network compared to DTA
- STTA is particularly suited to modelling large areas
- Also very useful to produce time-profiles demand for more detailed DTA analyses.

# Questions?

