PTV GROUP

the mind of movement

PTV Topics - Advanced Models in Visum

CAPACITY CONSTRAINED TRANSIT ASSIGNMENT

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OVERVIEW

1. Background
2. Methodology
3. Structure of Data Model
4. Application Case - WAMTA
5. Discussion/Remarks
6. Q/A

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BACKGROUND

Most state of practice models are macroscopic (4-step) with transit flows assigned with headway-based methods. However….

- Agencies are gradually transitioning toward microscopic (activity-based) models with higher granularity of modeled entities and also time and space
- Dynamic assignment on the auto side is frequently discussed, dynamic transit assignment not so much
- Methodology to incorporate time-dynamics (transit) into activity-based frameworks matched up with more realistic system constraints

METHODOLOGY – CAPACITY CONSTRAINTS

Capacity constraints in practice can take effect in different ways:

- **Absolute vehicle capacity**: The vehicle can hold only as many passengers as preset by its capacity (hard capacity).
- **Discomfort in the vehicle**: Passengers feel uncomfortable when travelling in a heavily loaded vehicle. This effect will increase if all seats are occupied.
- **Discomfort outside of the vehicle**: Passengers feel uncomfortable when transferring at highly frequented stops. Besides unpleasant effects due to overcrowding also delays may occur.

Soft capacity constraint aims to model possible discomfort for passengers in the vehicle.

SOFT CAPACITY CONSTRAINTS

- Soft constraints allow volume to capacity (theoretical) ratios greater than 1. However, journeys with higher volume to capacity (theoretical) ratios are discouraged by penalizing the impedance
- Has also been applied in the context of headway-based assignment (Spiess et al. (1993) Transit Equilibrium Assignment based on Optimal Strategies: An Implementation in EMME)

HARD CAPACITY CONSTRAINTS

- Hard constraints restrict volumes to not exceed vehicle capacity. Harder to solve
- Failure to board is considered explicitly

METHODOLOGY – SOFT CAPACITY CONSTRAINT CALCULATION

Soft capacities are incorporated into the transit path choice by iterative calculation of following steps:

1. Update route cost based on vol/cap ratio at the journey item level by applying a penalty function
2. Update time-varying route choice based on updated cost
3. Apply smoothing to final route volumes based on MSA or exponential smoothing
4. Check termination conditions (weighted volume deviation or maximum iterations)

METHODOLOGY – SOFT CAPACITY CONSTRAINT CALCULATION

Linear penalty function used for congested route cost is incorporated as shown below:

$$W_V = max(0, a \bullet A_v + b)$$

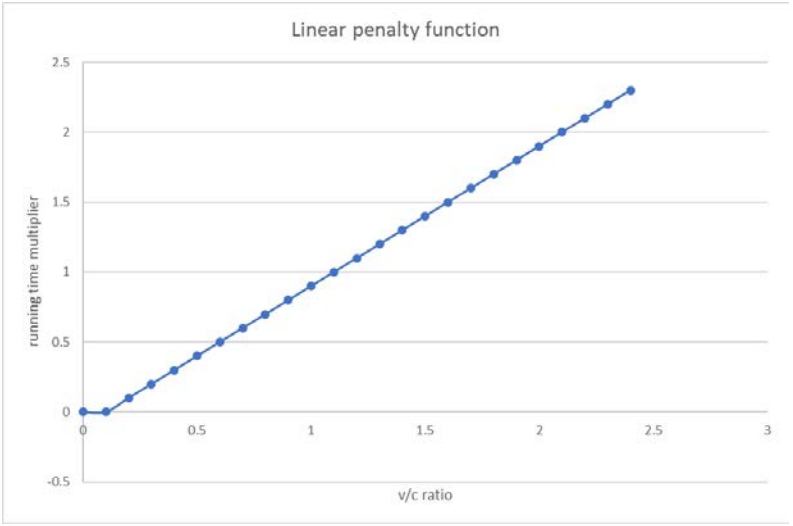
Where,

a is a multiplicative damping factor and b is an additive term (parameters)

Av is vol/cap ratio of vehicle

Overall route cost over all journey items v is thus updated as:

$$W_V = \sum_{v \in V} W_v \bullet run\ time_v$$

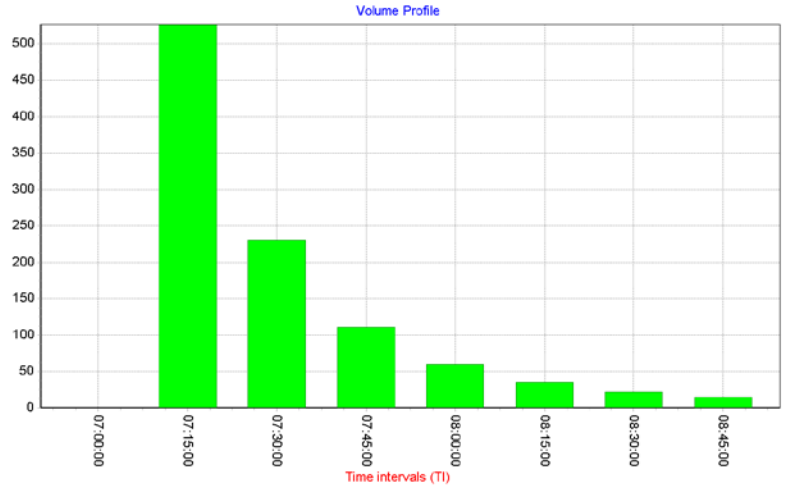


METHODOLOGY - CAPACITY SPECIFICATION AT JOURNEY LEVEL

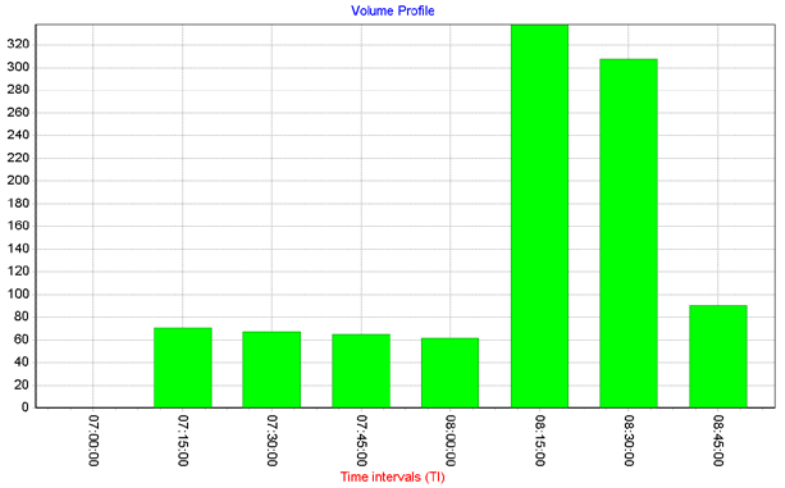
Number: 16	VehJourneyNo	No	TSysCode	Dep	VehCombIdentifier	VehComb\TotalCap
1	25	1	B	07:00:00	3 C3	50
2	26	1	B	07:15:00	3 C3	50
3	27	1	B	07:30:00	3 C3	50
4	28	1	B	07:45:00	3 C3	50
5	29	1	B	08:00:00	3 C3	50
6	30	1	B	08:15:00	3 C3	50
7	31	1	B	08:30:00	3 C3	50
8	32	1	B	08:45:00	3 C3	50
9	33	1	M	07:00:00	1 C1	120
10	34	1	M	07:15:00	1 C1	120
11	35	1	M	07:30:00	1 C1	120
12	36	1	M	07:45:00	1 C1	120
13	37	1	M	08:00:00	1 C1	120
14	38	1	M	08:15:00	2 C2	960
15	39	1	M	08:30:00	2 C2	960
16	40	1	M	08:45:00	1 C1	120

METHODOLOGY - SOFT CAPACITY CONSTRAINT RESULTS (LINE SECTION FLOW PROFILE)

Unconstrained flows

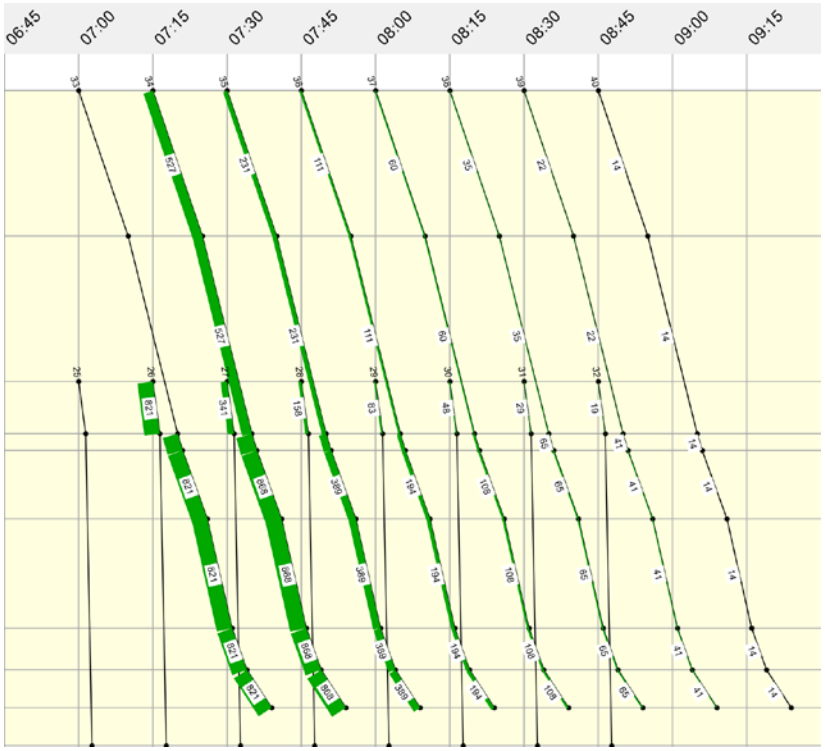


Capacity constrained flows

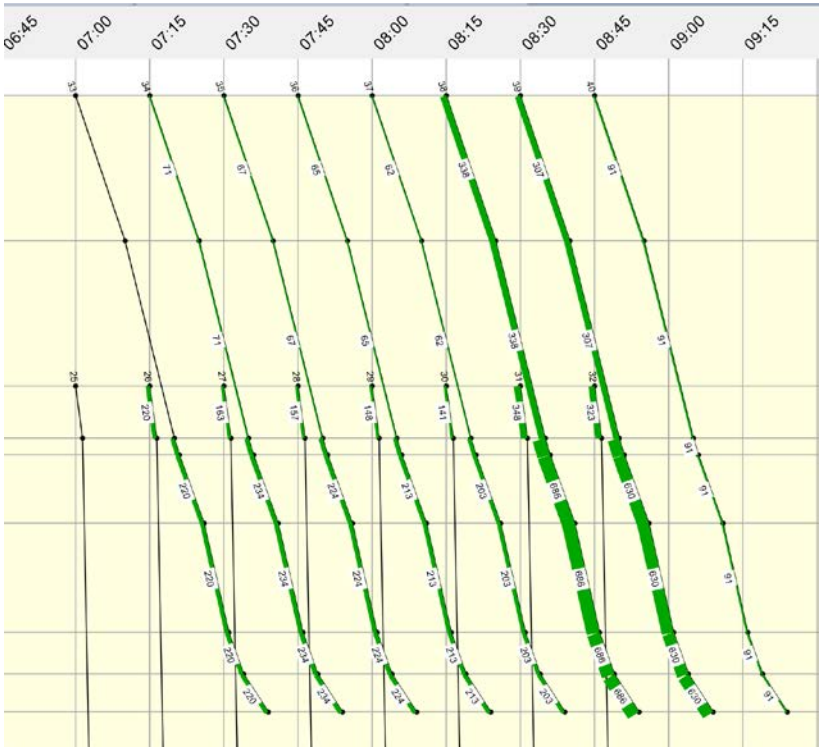


METHODOLOGY - SOFT CAPACITY CONSTRAINT RESULTS (TIME-SPACE VIEW)

Unconstrained flows



Capacity constrained flows



OUTPUT – DISCOMFORT SKIMS OR SHADOW PRICES

For feedback into ABM for plan adjustment…

Better modeling of transit ridership and mode choice…

Perceived journey time (PJT) =

be	Coefficient	Attribute
	1.00	In-vehicle time
+	1.00	PuT-Aux ride time
+	2.00	Access time
+	2.00	Egress time
+	2.10	Walk time
+	2.10	Origin wait time
+	2.10	Transfer wait time
+	7min	Number of transfers
+	0min	Number of operator change
+	0.00	Extended impedance

DeltaT = Time difference between desired and actual departure or arrival time

Impedance =

nbe	Coefficient	Attribute
	1.00	PJT [min]
+	0.00	Fare
+	1.00	DeltaT(early) [min]
+	1.00	DeltaT(late) [min]
+	10.00	Vol/cap ratio-dependent impedance

4 x 4			1	2	3	4
	Name					
		Sum	2999997.00	2999997.00	1000314.96	1000376.56
1		1000397.30	0.00	999999.00	159.14	239.17
2		1000294.21	999999.00	0.00	156.82	138.39
3		2999997.00	999999.00	999999.00	0.00	999999.00
4		2999997.00	999999.00	999999.00	999999.00	0.00

4 x 4			1	2	3	4
	Name					
		Sum	2999997.00	2999997.00	1001561.67	1000740.88
1		1001249.19	0.00	999999.00	764.89	485.29
2		1001053.37	999999.00	0.00	797.78	256.59
3		2999997.00	999999.00	999999.00	0.00	999999.00
4		2999997.00	999999.00	999999.00	999999.00	0.00