SIMULATIONS OF DIFFERENT SCENARIOS OF THE USE OF AUTONOMOUS VEHICLES WITH A MULTI-AGENT MODEL

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What could be impacts of autonomous vehicles ?

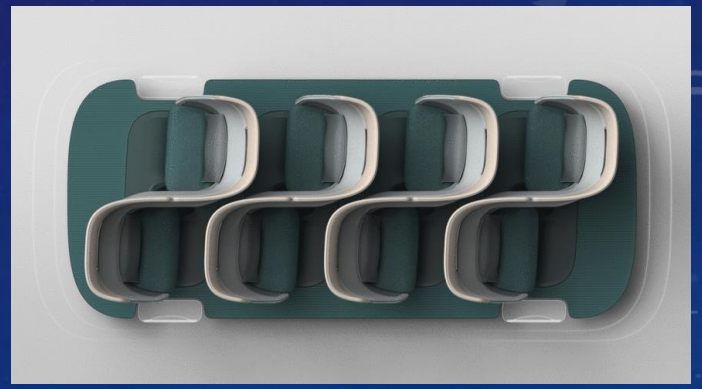
Answer throught a agent-based model : MATSim

SCENARIOS

private

shared

pooled



MODEL – DVRP CONTRIBUTIONS

private	shared	pooled
Adaptation from the taxi contribution New dispatcher : match the vehicle and the request with the household_id of the agent	Contribution taxi from M. Maciejewski, “Dynamic Transport Services,” in The Multi-Agent Transport Si-mulation MATSim, pp. 145–152, Axhausen, Kay W. and Horni, Andreas and Nagel, Kai, 2016. Dispatcher : rule-based	Contribution DRT J. Bischoff, M. Maciejewski, and K. Nagel, “City-wide shared taxis : A simulation study in Berlin,” in 2017 *IEEE 20th International Conference on Intelligent Transportation Systems (ITSC),* pp. 275–280, 2017. Dispatcher : Insertive

SCENARIO DESCRIPTION

- Fleet size, how many vehicles and where ?
- Score of the new mode : $U_{AV} = C + \beta_{time} * time + \beta_{km} * distance + price$
- With $price = \begin{cases} base\ fare + distance\ fare * distance + time\ fare * time \\ min\ fare \end{cases}$

SCENARIO DESCRIPTION

Scenario	private	shared	pooled
Fleet size	1 vehicle/household Front of each house	10 % of demand On residential links in the island	10 % of demand On residential links in the island 4 seats
Distance cost	Same as conventional car	Same as conventional car + 30 % of margin	(Same conventional as car + 30 % of margin) / occupancy
Perception of time on boars	¾ of value for public transit	¾ of value for public transit	Same as public transit
Min fare		Distance cost * Q1_distance	Distance cost * Q1_distance

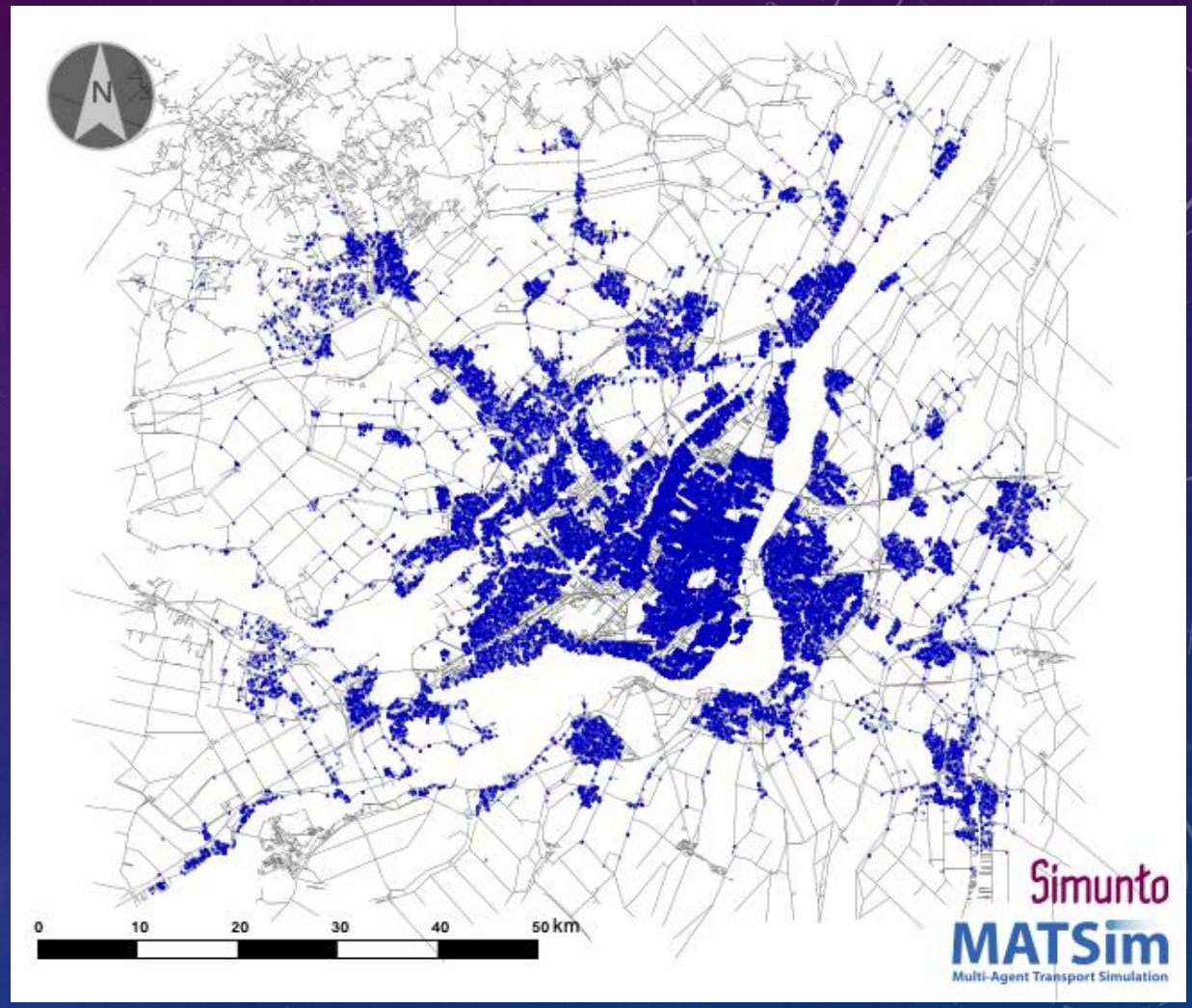
MANAGE NON ACCESS TO PRIVATE VEHICLES

- Fleet of autonomous vehicles created on the population, PAV_id = household_id
- Avoid this mode choice for unmotorized agent : creation of subpopulation

MONTREAL CASE

Metropolitain area of Montreal :
4 millions inhabitants
4300 km^2

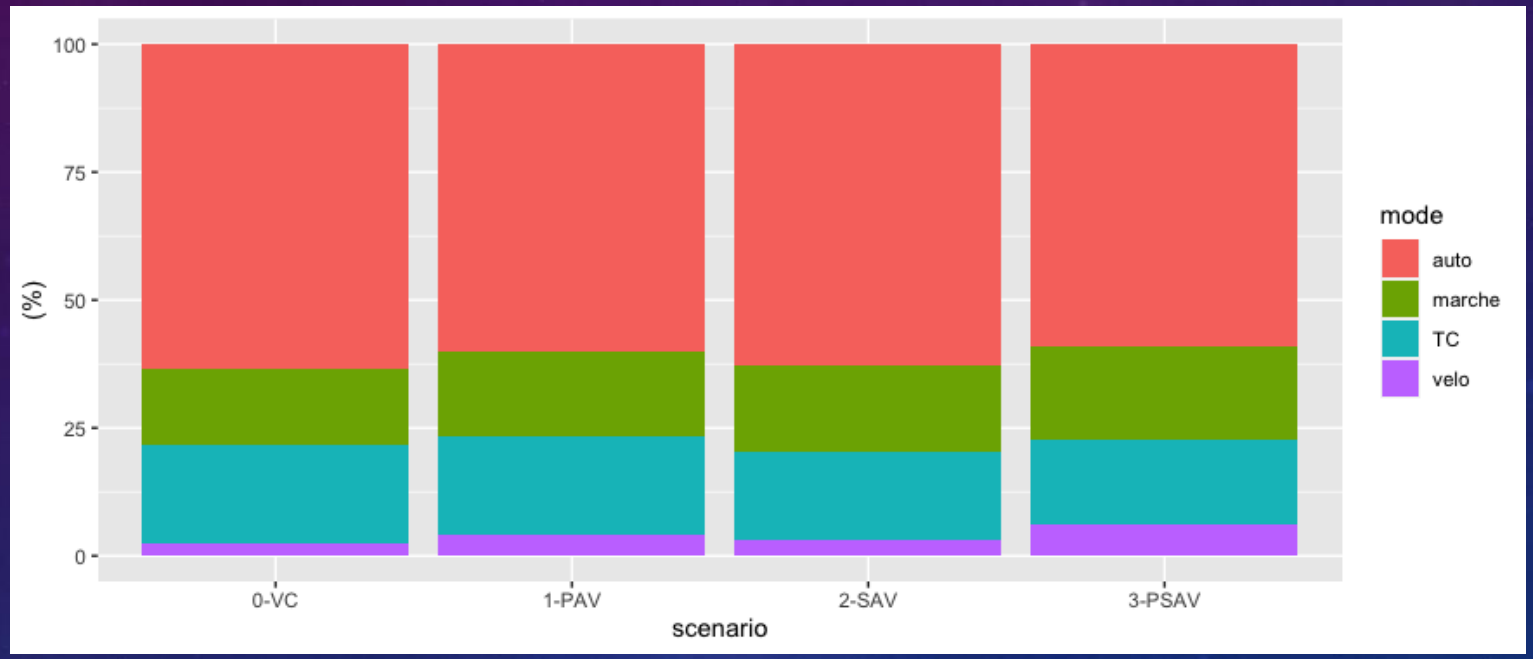
Scenario 5 % in MATSim :
159 000 agents
300 000 links
123 000 nodes



MAIN RESULTS

- Modal share
- Congestion
- VKT
- Gases emissions
- Service level

MODAL SHARE

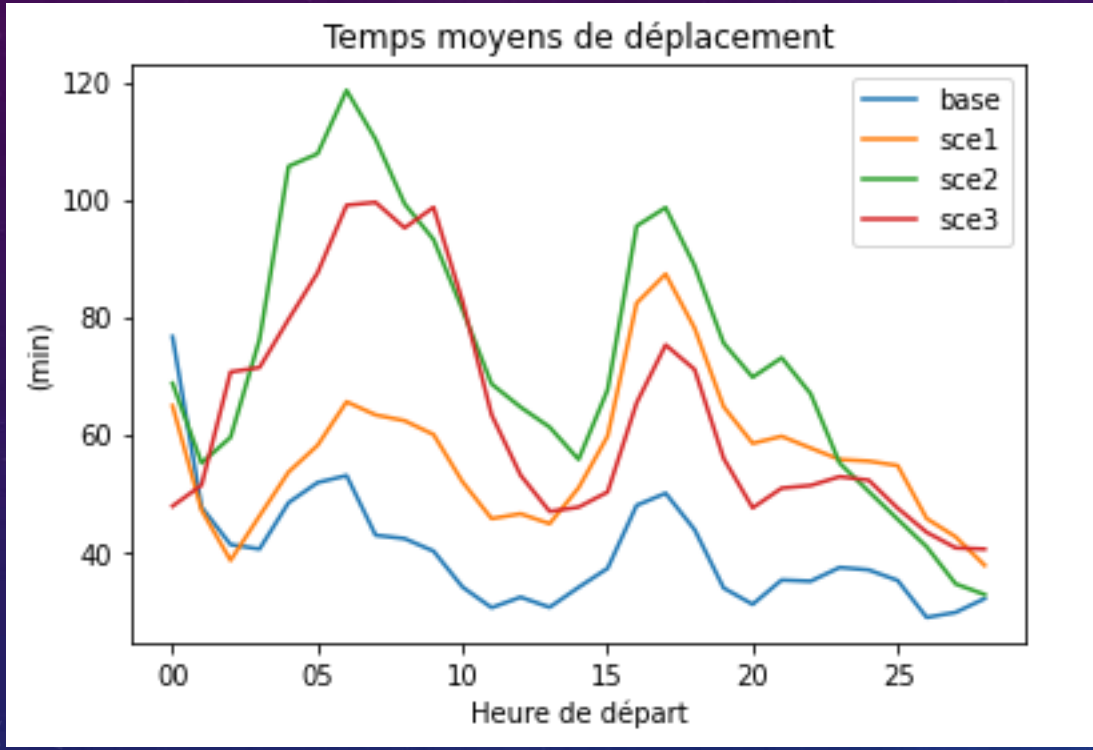


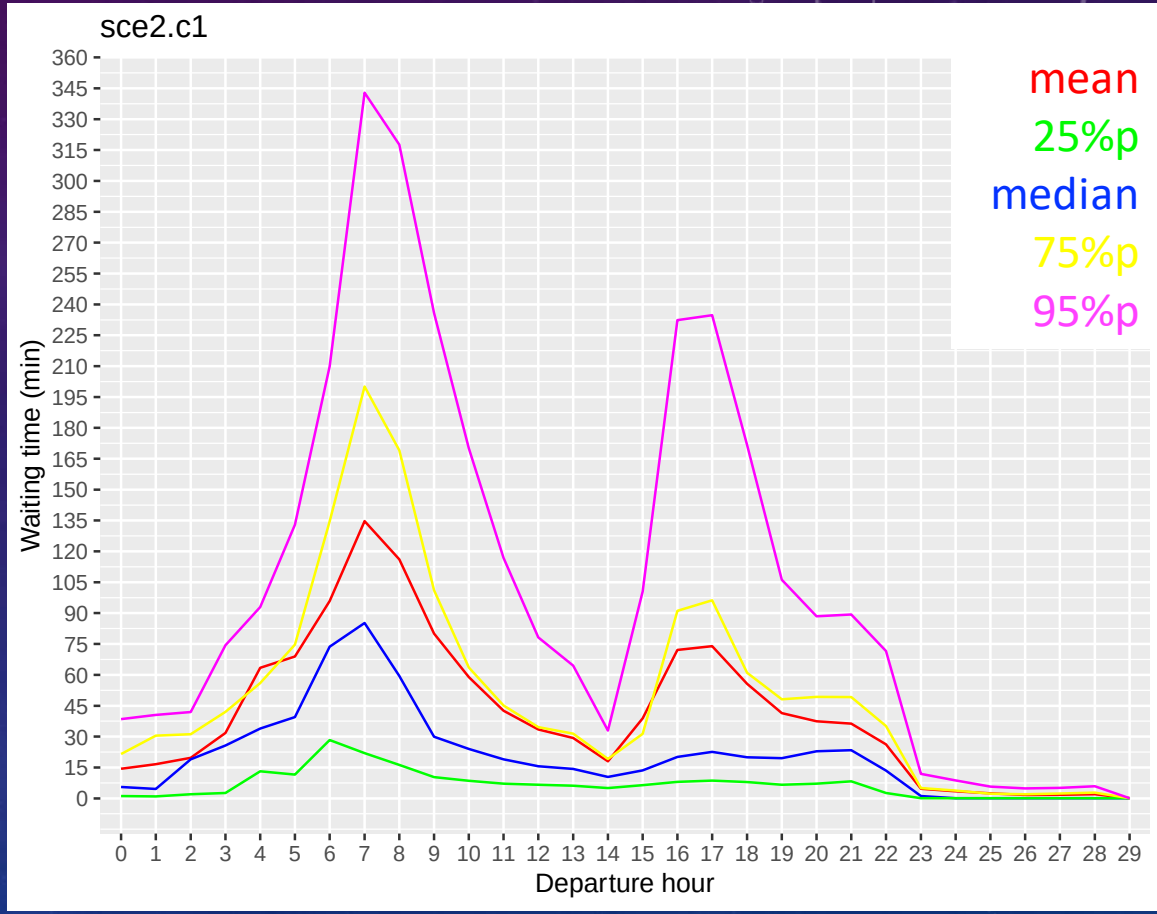
Conservation of modal share

VEHICLE KILOMETER TRAVELLED

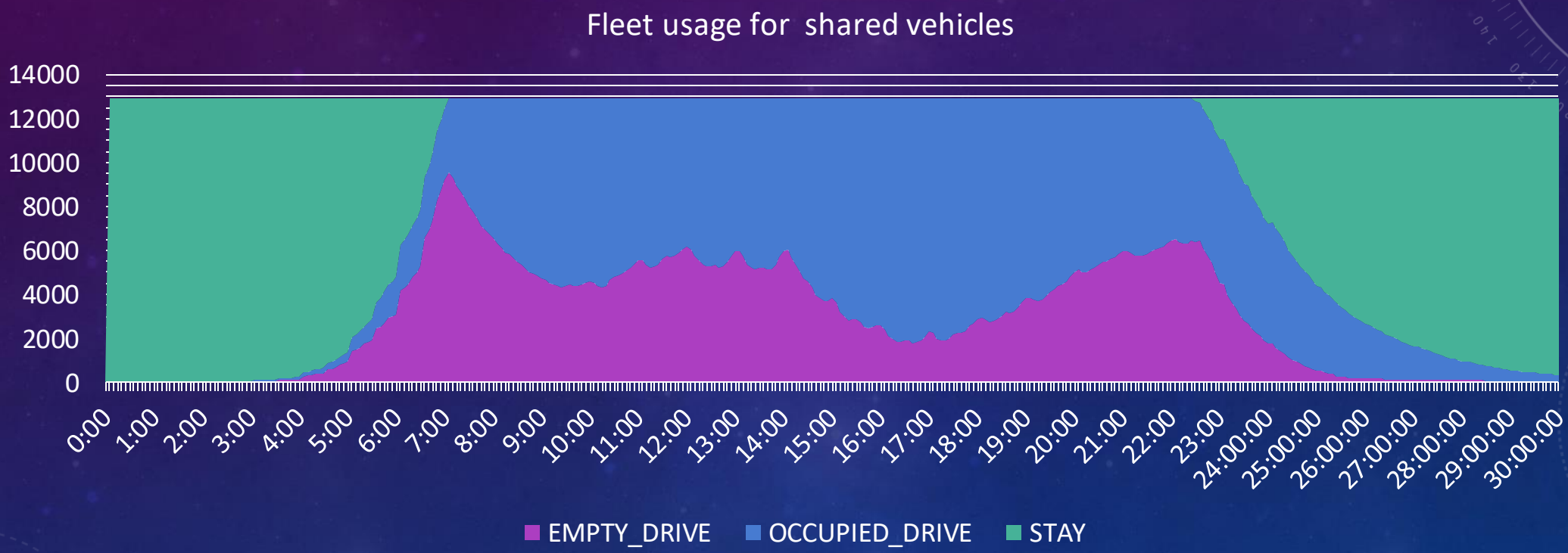
Scénario	0 - VC	1 - PAV	2 - SAV	3 - PSAV
VKT (10^6 km)	2.98	5.11 + 71%	5.12 + 72%	4.14 +39 %
%km à vide	-	31	31	21
Conso. Énergie (10^6 MJ) *	35.5	54.7 +54 %	38.1 +8 %	28.6 - 19 %
Émission GES (10^9 g GEG) *	2.36	3.64 + 54%	2.94 + 25%	2.21 -6 %

TRAVEL AND WAITING TIME

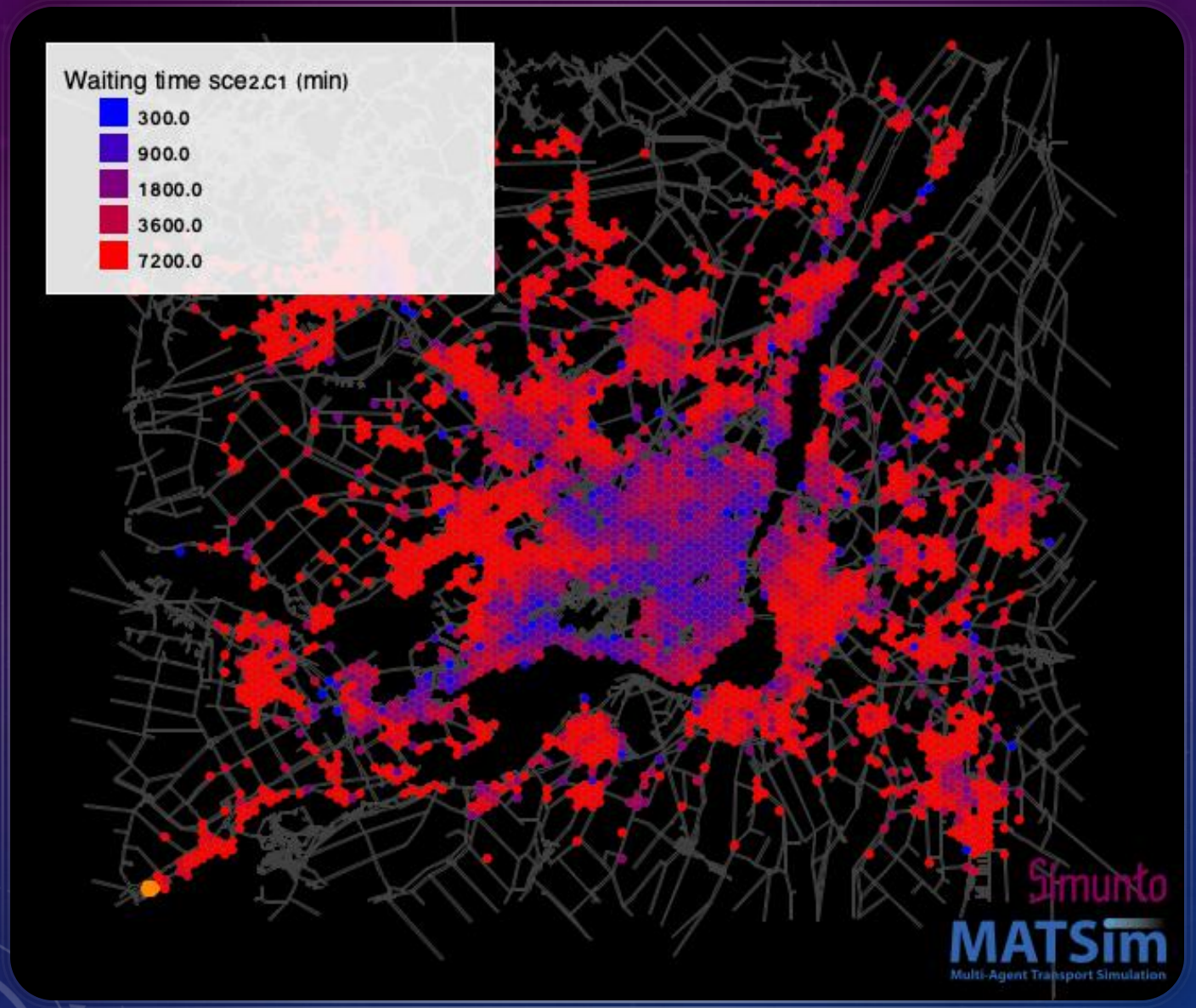




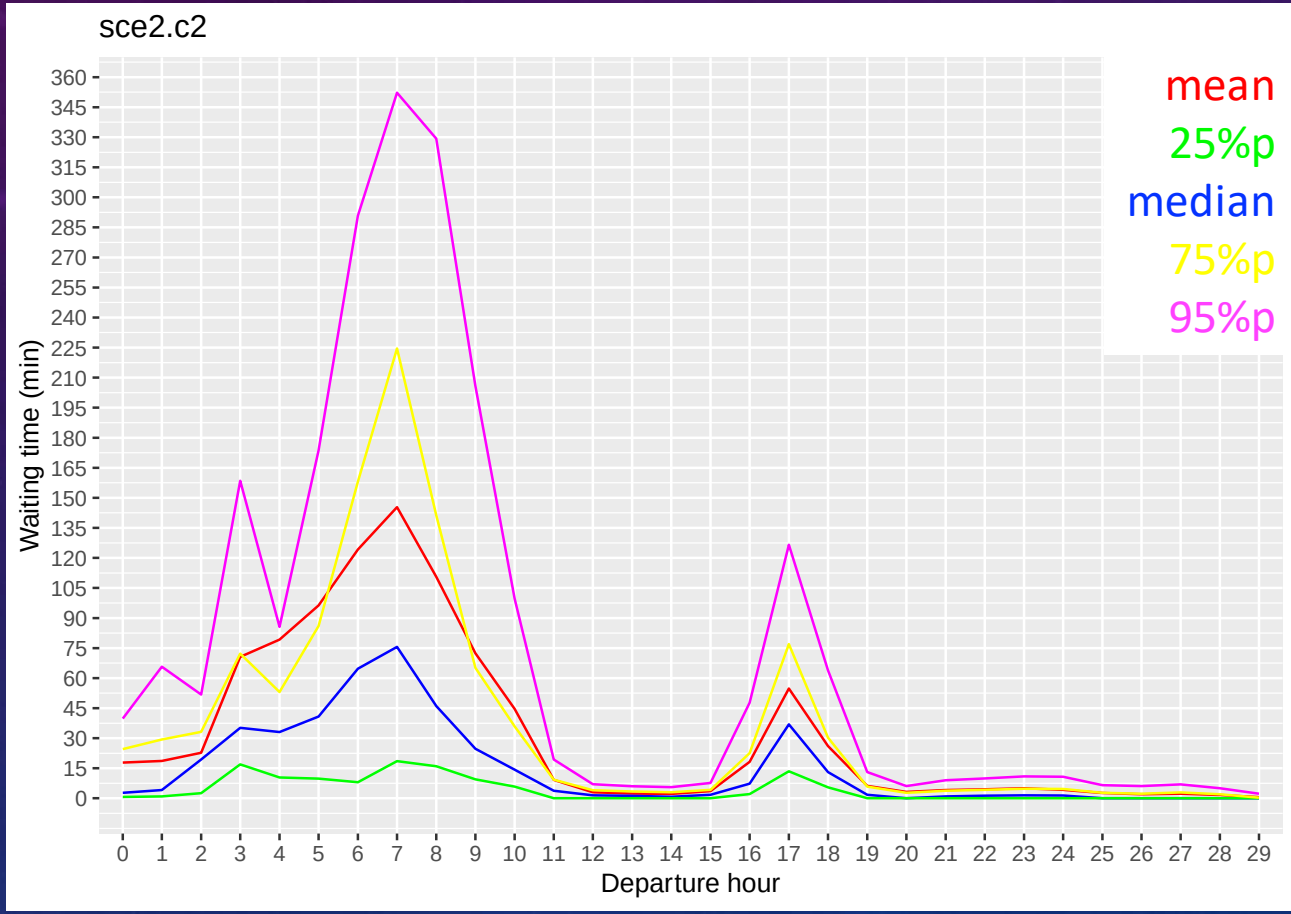
FLEET USAGE


Fleet usage for shared vehicles
14000
12000
10000
8000
6000
4000
2000
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
24:00:00
25:00:00
26:00:00
27:00:00
28:00:00
29:00:00
30:00:00
EMPTY_DRIVE
OCCUPIED_DRIVE
STAY

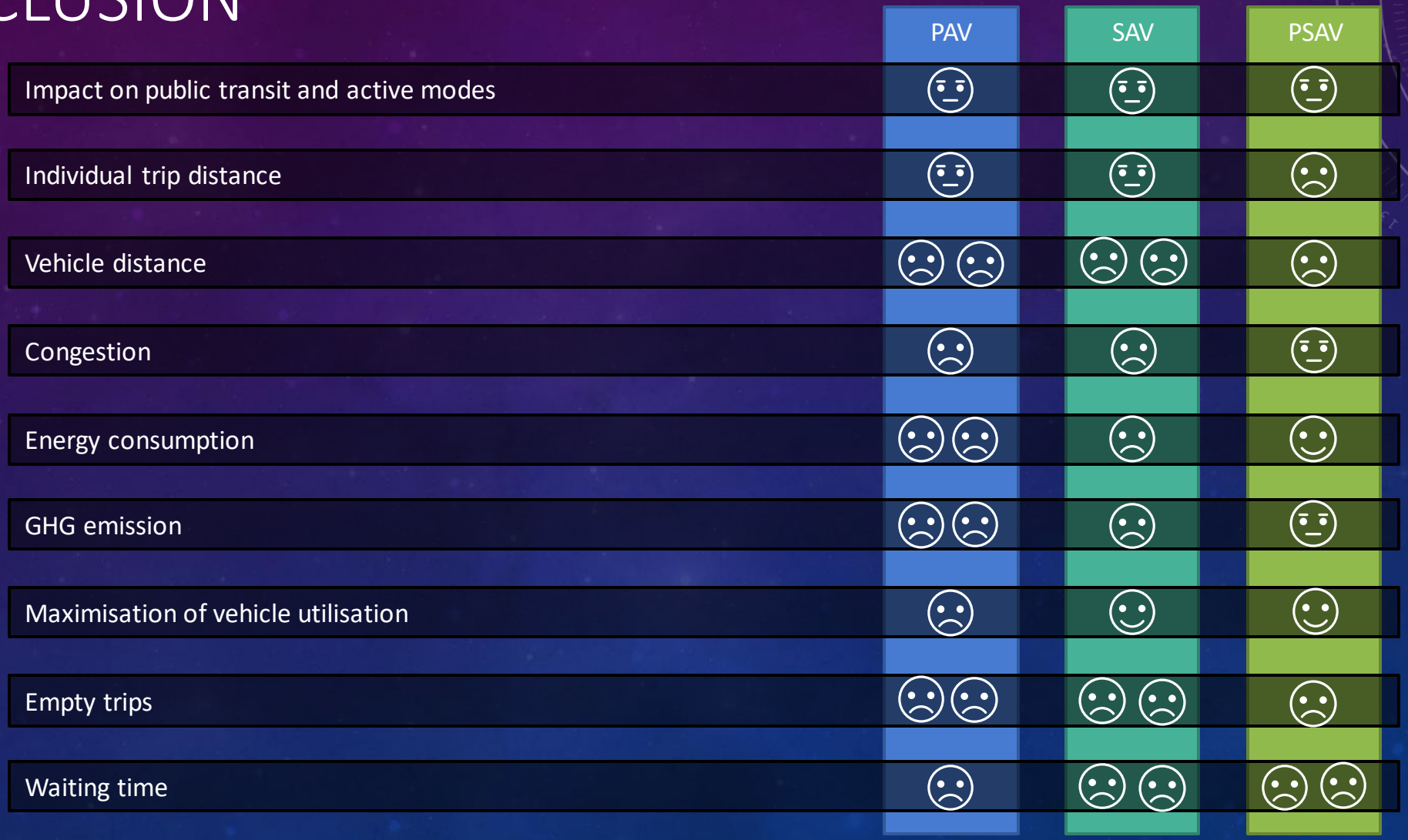
WAITING TIME FOR SHARED FLEET



INCREASE FLEET SIZE TO 20% OF DEMAND



CONCLUSION


PAV
SAV
PSAV
Impact on public transit and active modes
Individual trip distance
Vehicle distance
Congestion
Energy consumption
GHG emission
Maximisation of vehicle utilisation
Empty trips
Waiting time

FUTHER WORK AND IMPROVEMENT

- Good size for the fleet
- Score adjusment (calibration)
- Implement parkings
- Comparision with the city of Lyon
- Include carsharing between household for private autonomous vehicles based on DRT

CHALLENGE IN COMPUTATION TIME

Computation time :

- Based scenario of Montreal : 3 min per iteration
- Taxi contribution : 2h30 per iteration
- DRT contribution : 9h per iteration

THANK YOU FOR YOUR ATTENTION