Multimodal trip simulation for transit planning

Tim Spurr, Product Owner

Zoom sur l'intelligence numérique collaborative
April 21, 2021

Introduction

Multimodal travel:

DEFINITION: USE OF MULTIPLE MODES (TRANSIT, CAR, BICYCLE, SCOOTER) TO COMPLETE A SINGLE TRIP

FACILITATES TRANSIT USE IN LOW-DENSITY SUBURBS

COMPETES WITH REGULAR TRANSIT IN CERTAIN CONTEXTS

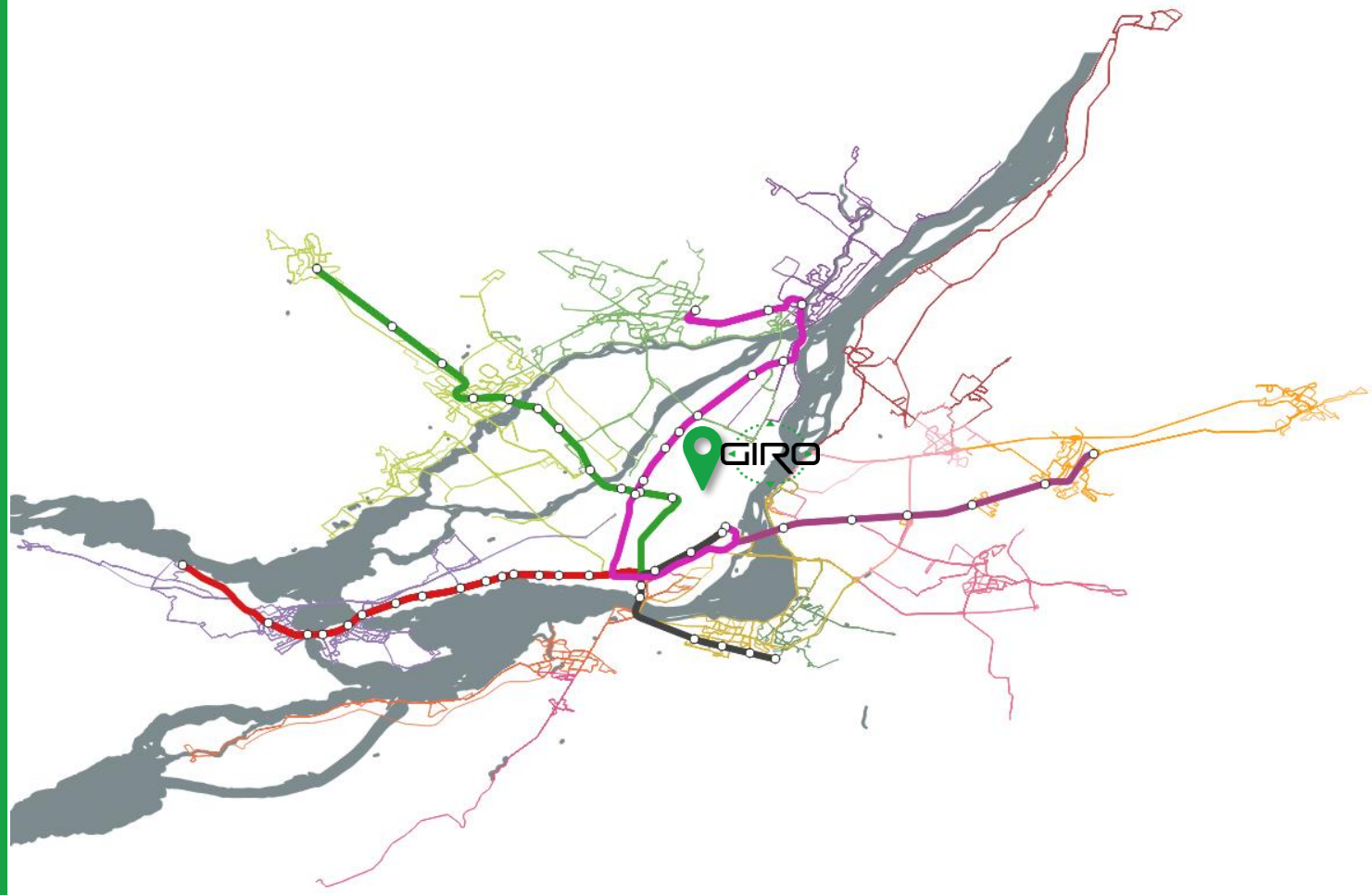
INCREASINGLY POPULAR/DISRUPTIVE (BIKESHARE, UBER…)

DEMAND PATTERNS ARE HARD TO PREDICT

Collaboration

GIRO – provider of software to optimize operations of public transit services

Exo – provider of train and bus services in the suburban regions surrounding Montreal, Laval and Longueuil



Challenge

REM project: a light rail network that will replace direct-to-downtown bus service over the Champlain Bridge

Today

Challenge

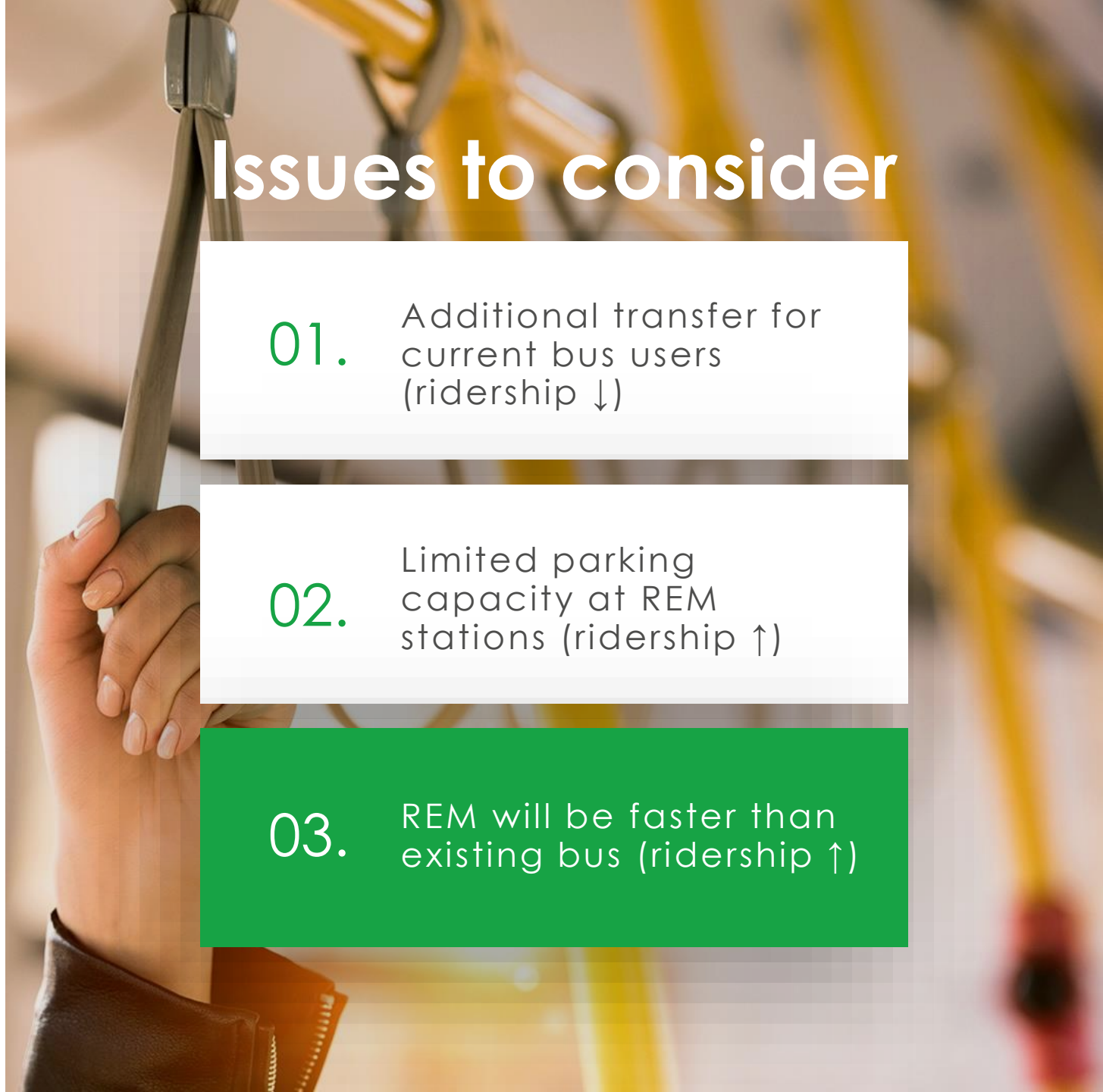
REM project: a light rail network that will replace direct-to-downtown bus service over the Champlain Bridge

2022

Main question for exo

What will be the effect on ridership?

NOTE: This isn't an evaluation of the REM project



Issues to consider

01. Additional transfer for current bus users (ridership ↓)

02. Limited parking capacity at REM stations (ridership ↑)

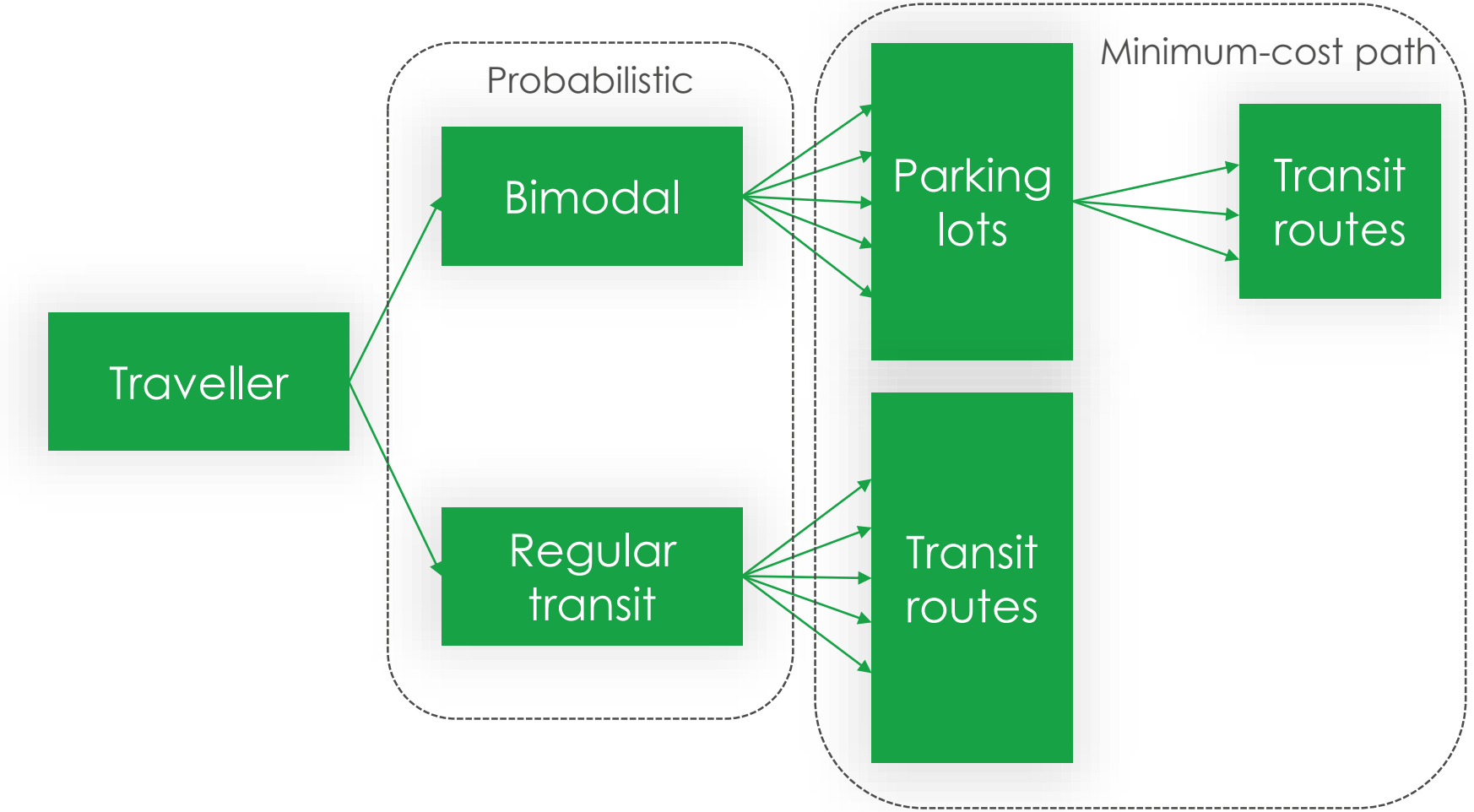
03. REM will be faster than existing bus (ridership ↑)

GIRO's contribution

Customer Impact Simulator (CIS) in HASTUS – a planning tool that estimates the impact of proposed service changes on transit users

New development: incorporate into the CIS trips that use both a private mode (car, bicycle) and a public mode (transit).

Simulating multiple traveller choices…



Multimodal simulation model

IMPORTANT ELEMENTS

Schedule-based trip assignment

Penalties applied manually to parking lots as they fill up

Mode share (pure transit vs bimodal) is dependent on bimodal travel costs

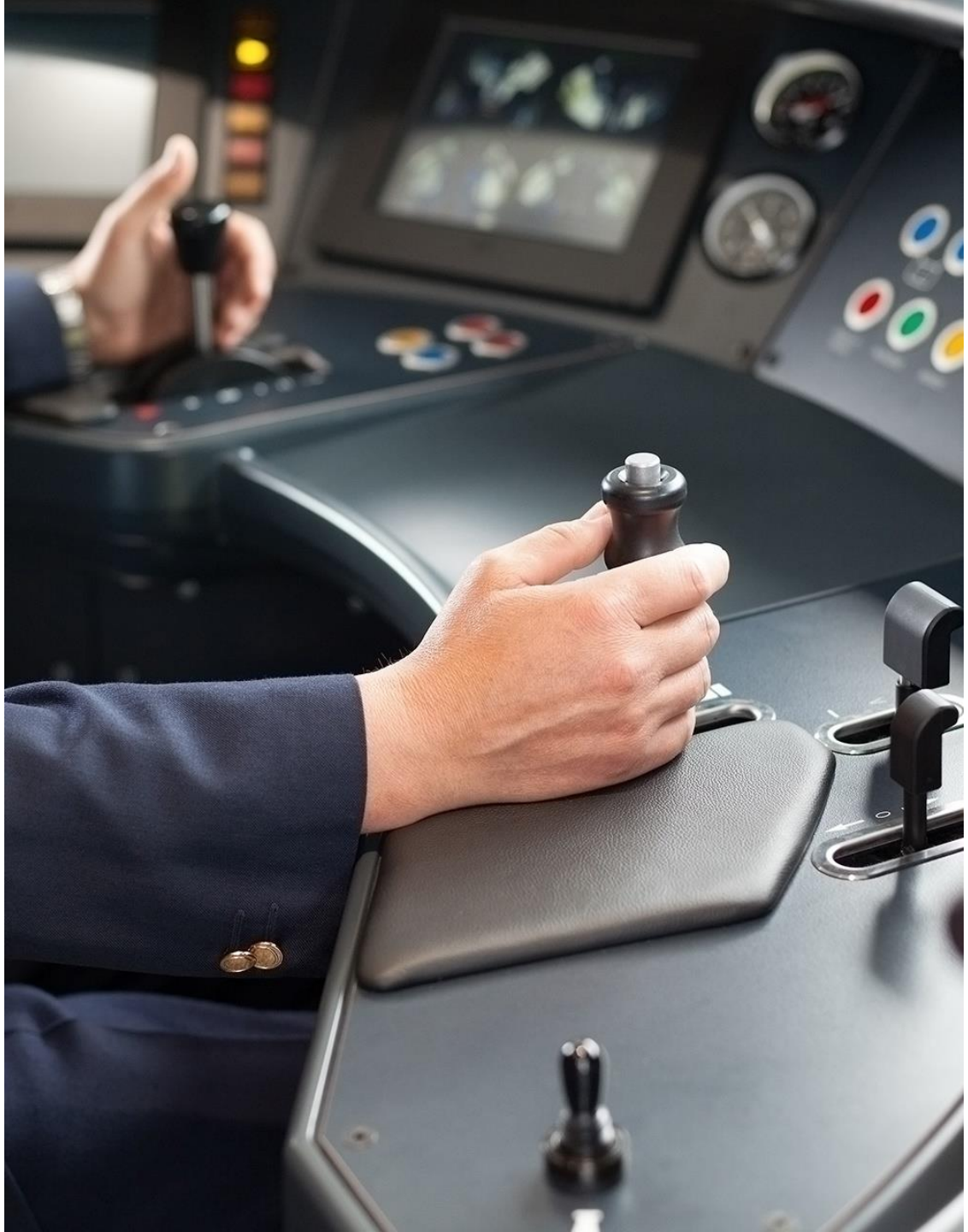
LIMITATIONS

Parking capacities are not strict constraints

Traffic conditions are not considered explicitly

Only inbound (morning peak period) trips are simulated

Algorithm is not iterative



INPUT DATA

Test case: Vaudreuil train line

Is the model sensitive to service levels and parking capacity?

Preliminary data.
Model not calibrated.

INPUT DATA

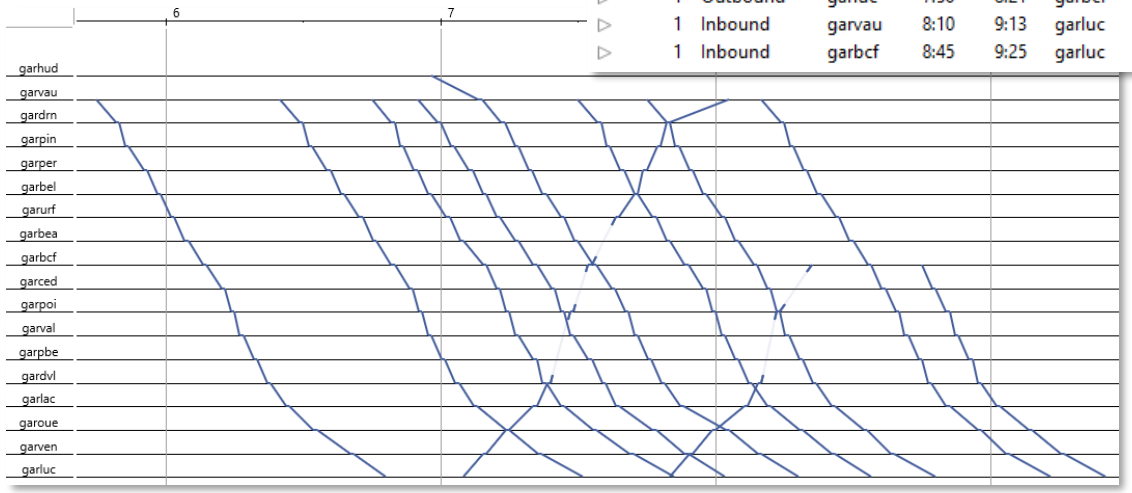
Service offer

Complete train, bus and metro schedules for the region

14 Parking lots on the Vaudreuil train line

Train service (Filtered)

Route	Direction	From	Start	End	To	Hdw	Duration	Trp speed	Nb stops
1	Inbound	garvau	5:45	6:48	garluc	0h40	1h03	39.59	17
1	Inbound	garvau	6:25	7:31	garluc	0h20	1h06	37.79	17
1	Inbound	garvau	6:45	7:51	garluc	0h10	1h06	37.79	17
1	Inbound	garvau	6:55	8:02	garluc	0h35	1h07	37.23	17
1	Inbound	garhud	6:58	8:18	garluc		1h20	38.64	18
1	Outbound	garluc	7:05	8:03	garvau	2h50	0h58	43.01	13
1	Inbound	garvau	7:30	8:34	garluc	0h15	1h04	38.97	17
1	Inbound	garvau	7:45	8:48	garluc	0h25	1h03	39.59	17
1	Outbound	garluc	7:50	8:21	garbcf		0h31	46.00	7
1	Inbound	garvau	8:10	9:13	garluc	3h05	1h03	39.59	17
1	Inbound	garbcf	8:45	9:25	garluc		0h40	35.64	10



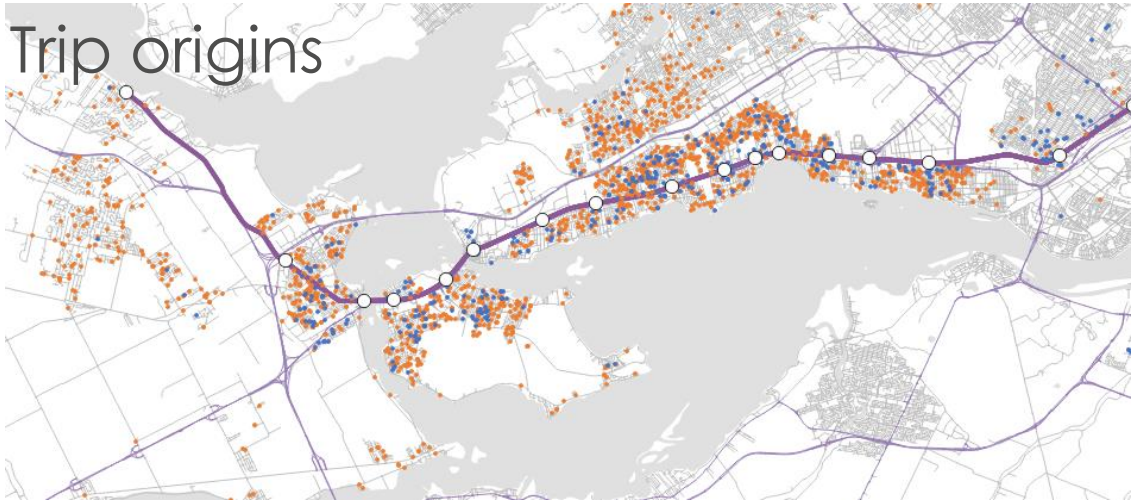
Parking lot	Estimated capacity
Hudson	64
Vaudreuil	860
Dorion	141
Pincourt	311
Île-Perrot	383
Ste-Anne-de-Bellevue	393
Baie-d'Urfé	99
Beaurepaire	56
Beaconsfield	619
Cedar Park	38
Pointe-Claire	804
Valois	199
Dorval	509
Montréal-Ouest	16
TOTAL	**4,493**

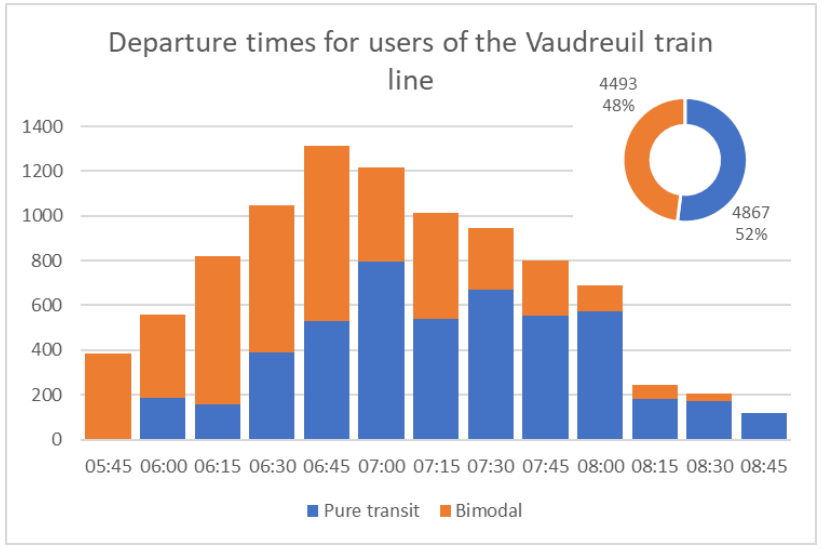
INPUT DATA

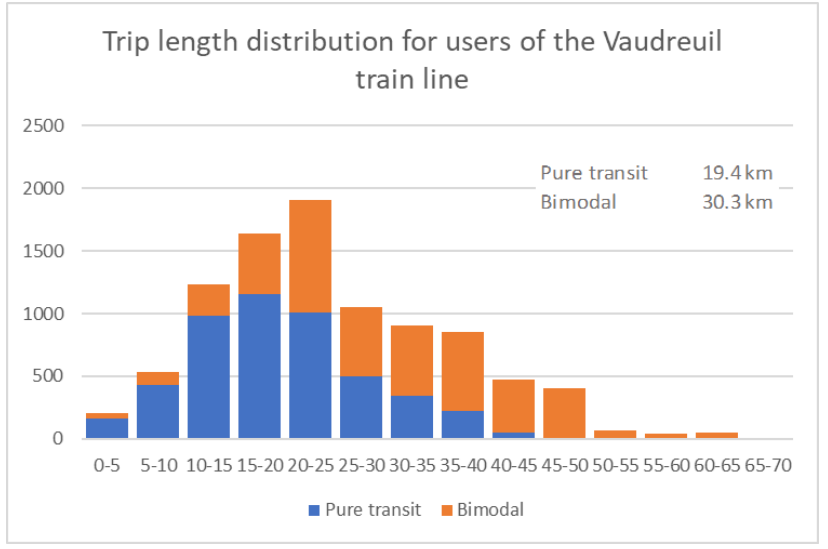
Travel demand

Detailed information on 2,868 observed trips:

- Household travel survey (by telephone and web)
- On-board survey (paper form)







Model parameters

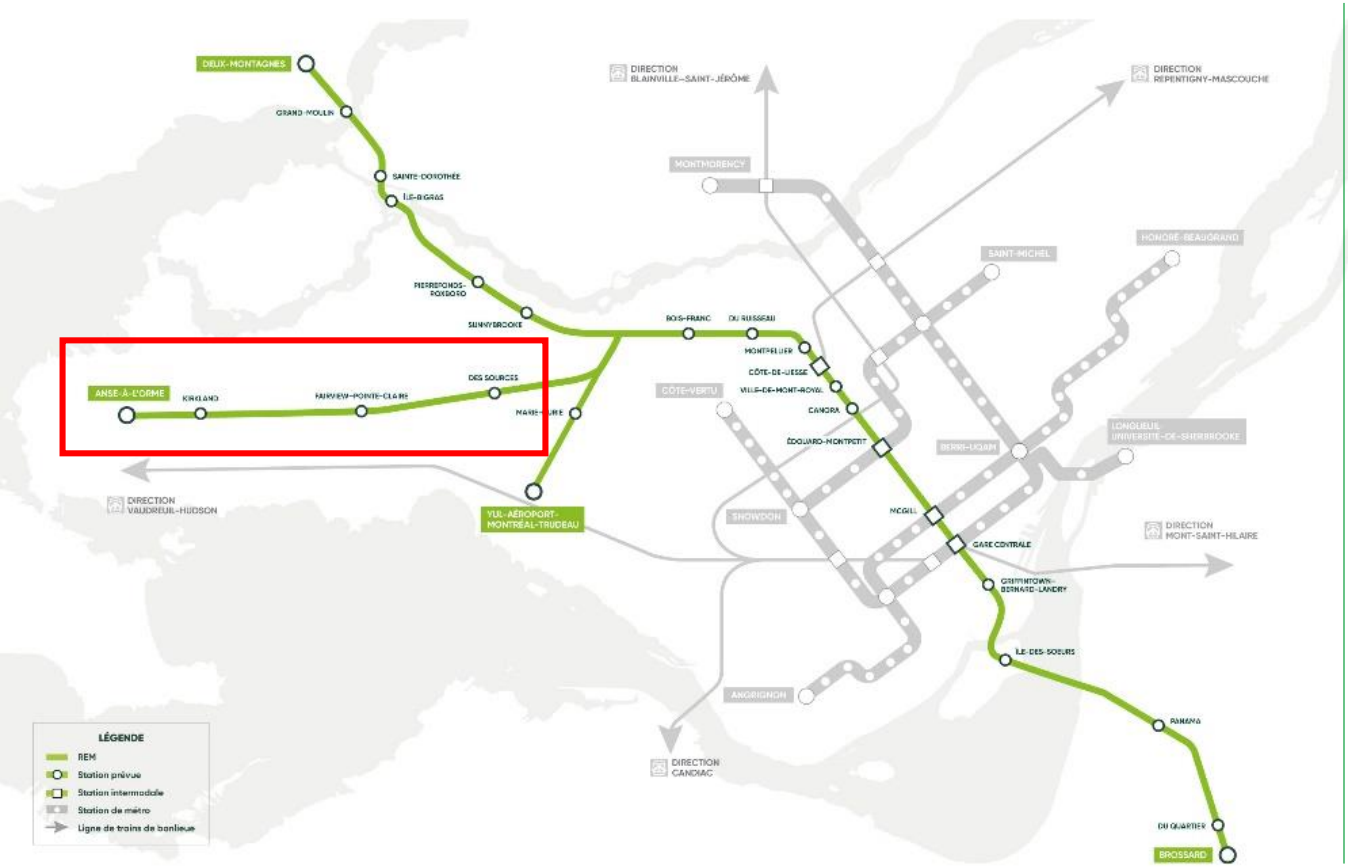
Binary choice (pure transit or bimodal transit)

Regression model using simulated travel times as explanatory variables

Explanatory variable	coef	z	Pr(>|z|)
Access time by car	0.0466	5.501	0.000
Total waiting time	-0.0607	-11.78	0.000
Total walking time	-0.0593	-6.279	0.000
In-vehicle time (bus)	-0.0345	-13.329	0.000
In-vehicle time (metro)	-0.0267	-1.969	0.049
Parking penalty	-0.0200	-15.261	0.000
Initial log-likelihood	-1781		
Finial log-likelihood	-1316		
Rho-squared	0.262		

		Simulated				
	Mmodal	Yes	No	TOTAL	% Correct	Share
Observed	Yes	1387	164	**1551**	89.4%	60.4%
	No	457	562	**1019**	55.2%	39.6%
	TOTAL	**1844**	**726**	**2570**		
	% Error	18.9%	-28.8%		**75.8%**	
	Share	71.8%	28.2%			

Test scenarios



01. Base (50/50) diversion, no parking penalties

02. Calibrated diversion, no parking penalties

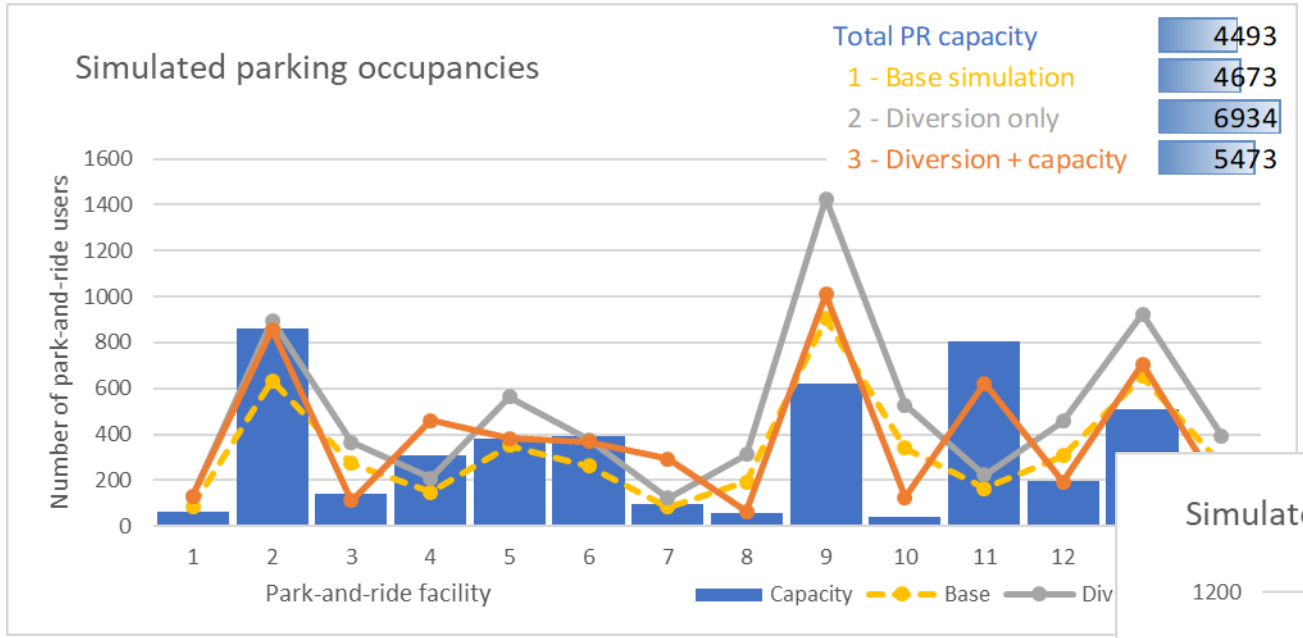
03. Calibrated diversion and parking penalties

04. Calibrated diversion, parking penalties and REM (West Island branch)

Source: https://www.cdpqinfra.com/fr/projets/rem

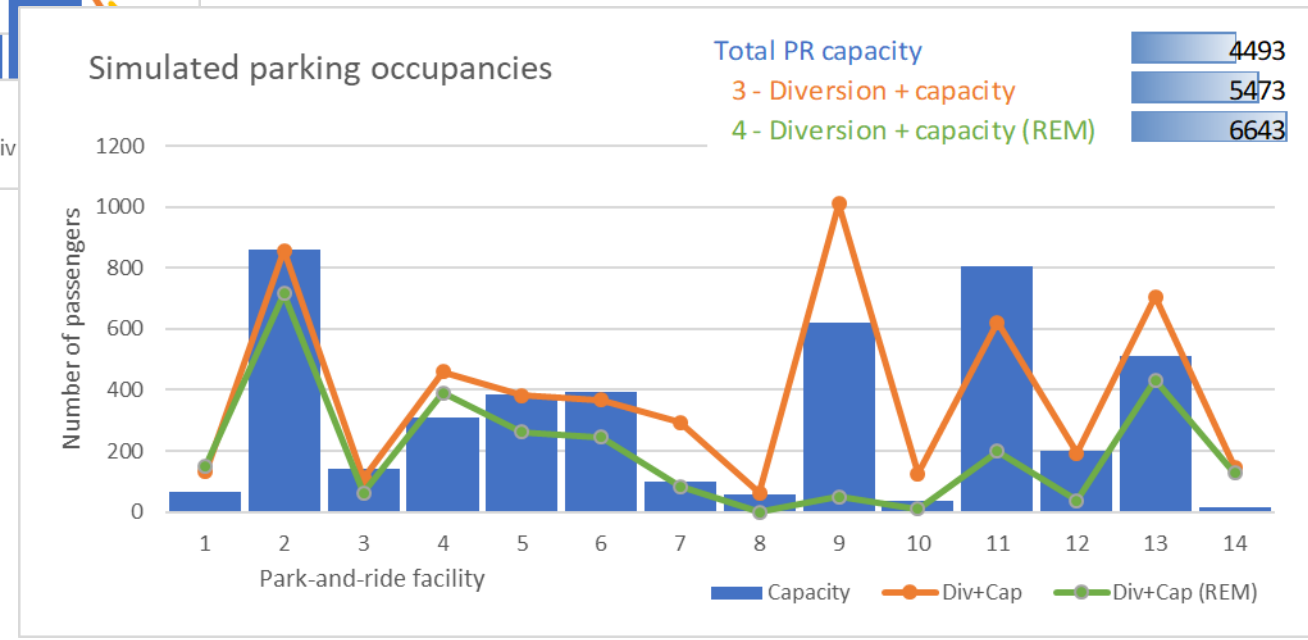
(PRELIMINARY TESTS)

Results



Diversion increases simulated multimodal demand (overestimation)

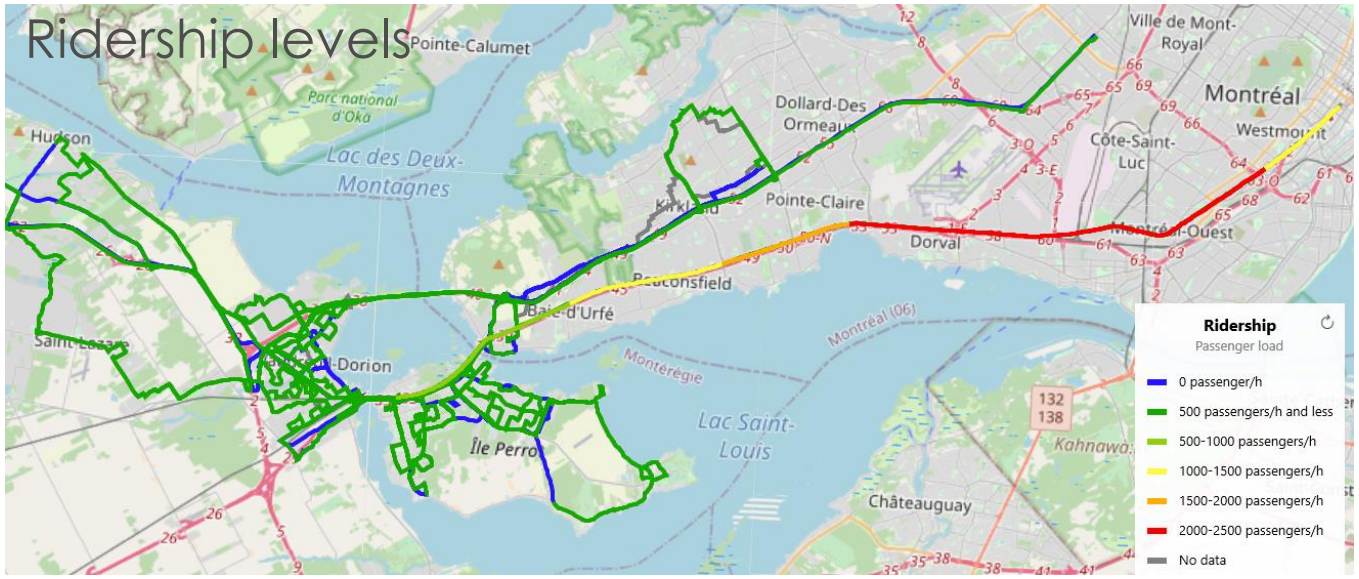
Capacity penalties reduce multimodal demand



Addition of the REM reduces demand for the Vaudreuil train but increases total multimodal demand

(PRELIMINARY TESTS)

Detailed results offer interesting visualization possibilities…



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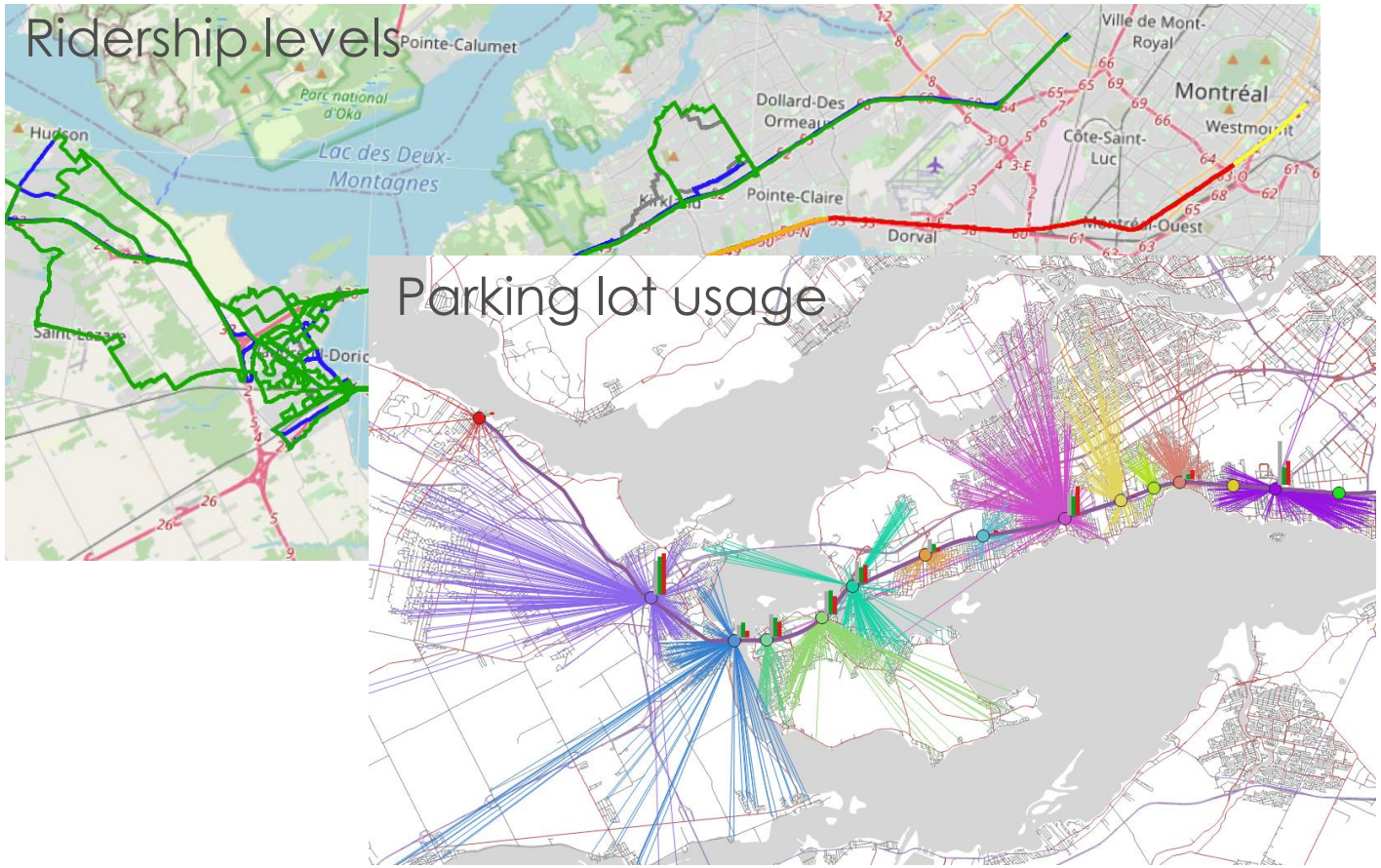
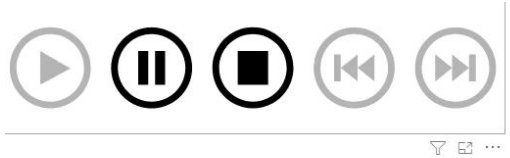


(PRELIMINARY TESTS)

Detailed results offer interesting visualization possibilities…

Dynamic train and parking occupancy



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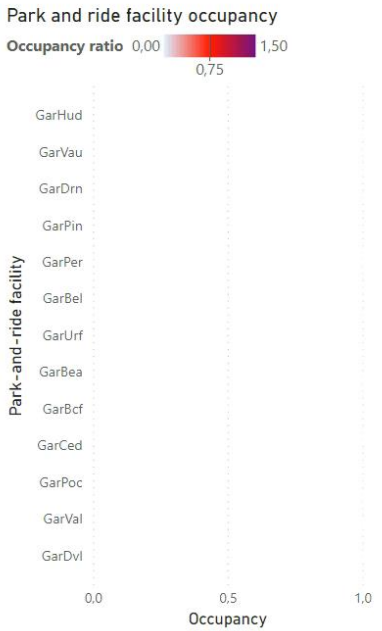
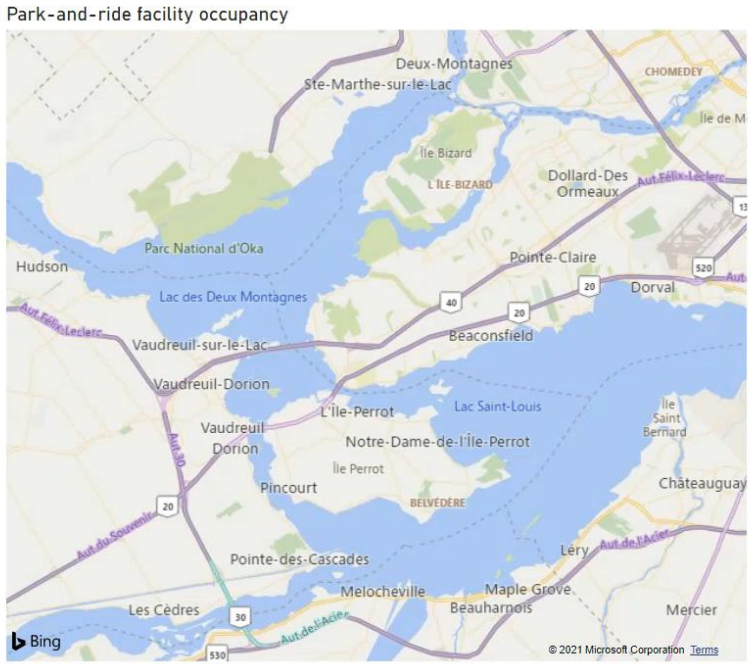
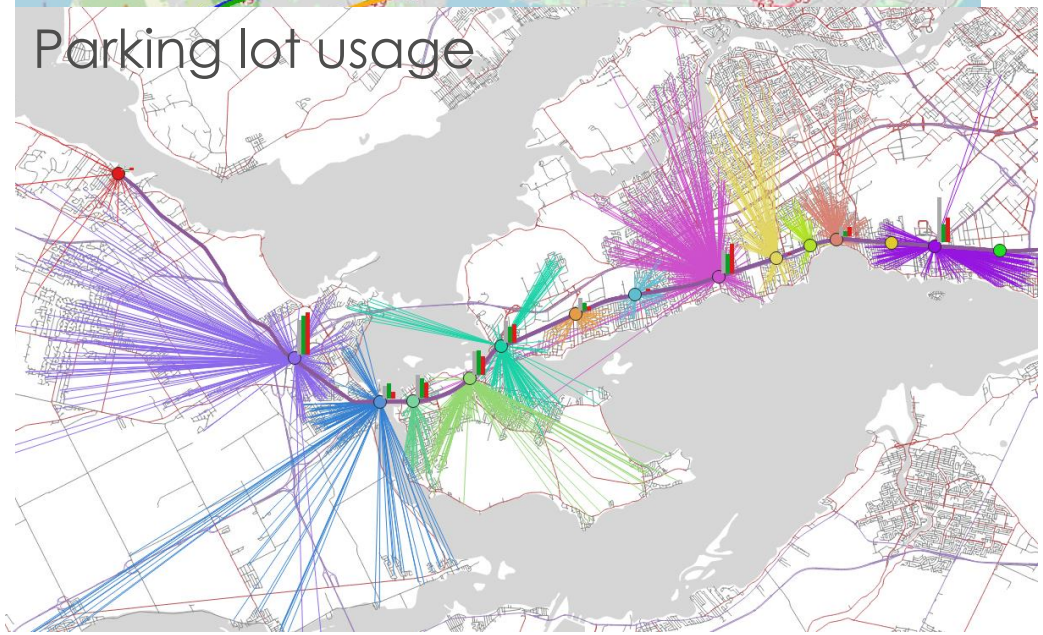


Trip	Most recent station	Passenger load
1	GarVau	0



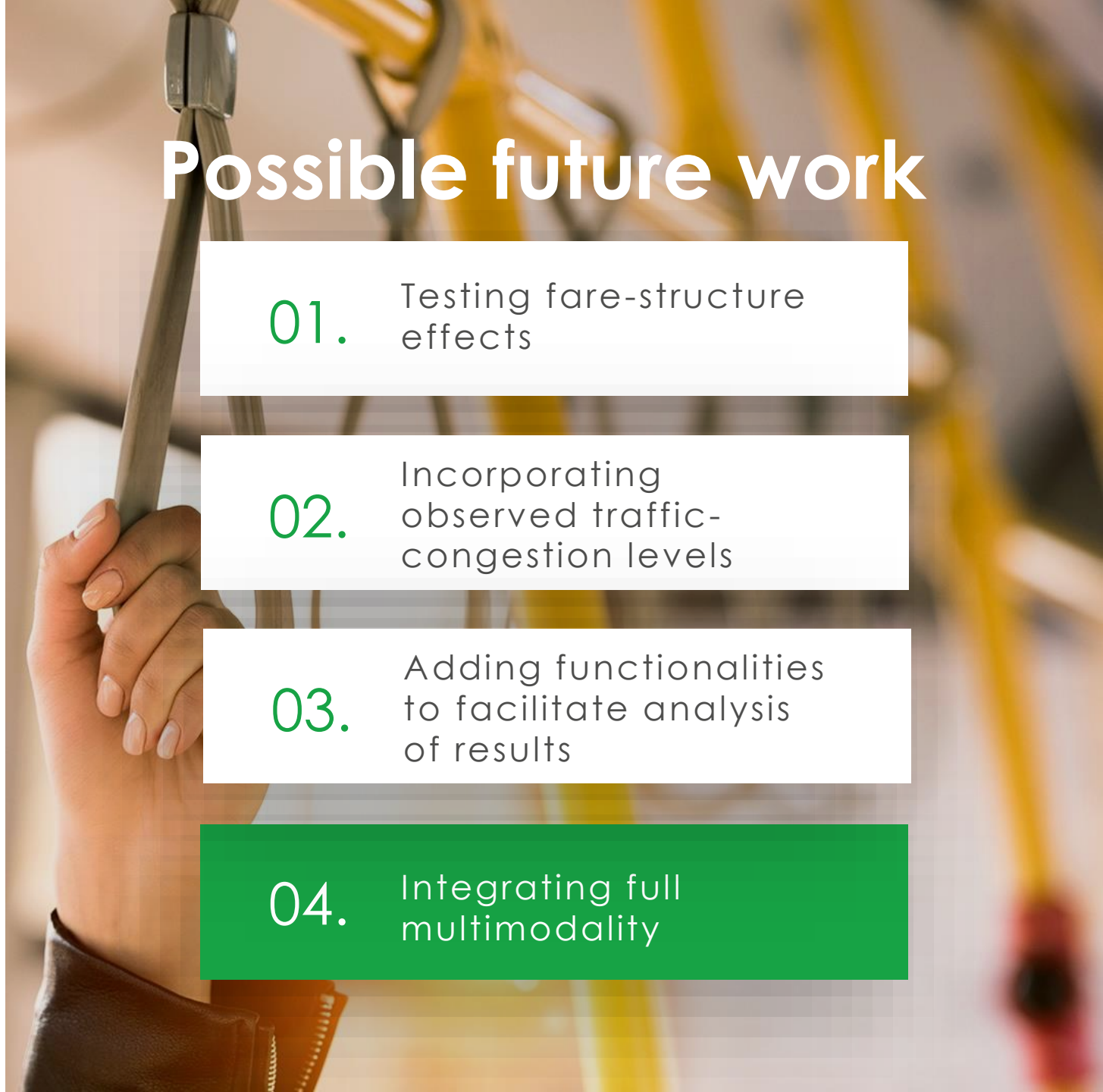
Ridership levels

Parking lot usage



Conclusions

The tests demonstrate that the simulated choices of *mode* and *route* are indeed sensitive to transit service levels and parking lot capacity.



Possible future work

01. Testing fare-structure effects

02. Incorporating observed traffic-congestion levels

03. Adding functionalities to facilitate analysis of results

04. Integrating full multimodality

Thank you to Julien Grégoire and his team at exo for their collaboration on this project.

THANK YOU!

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