

# Harmonization Management System

Bern Grush  
UTTRI, June 28, 2018

Supported by:



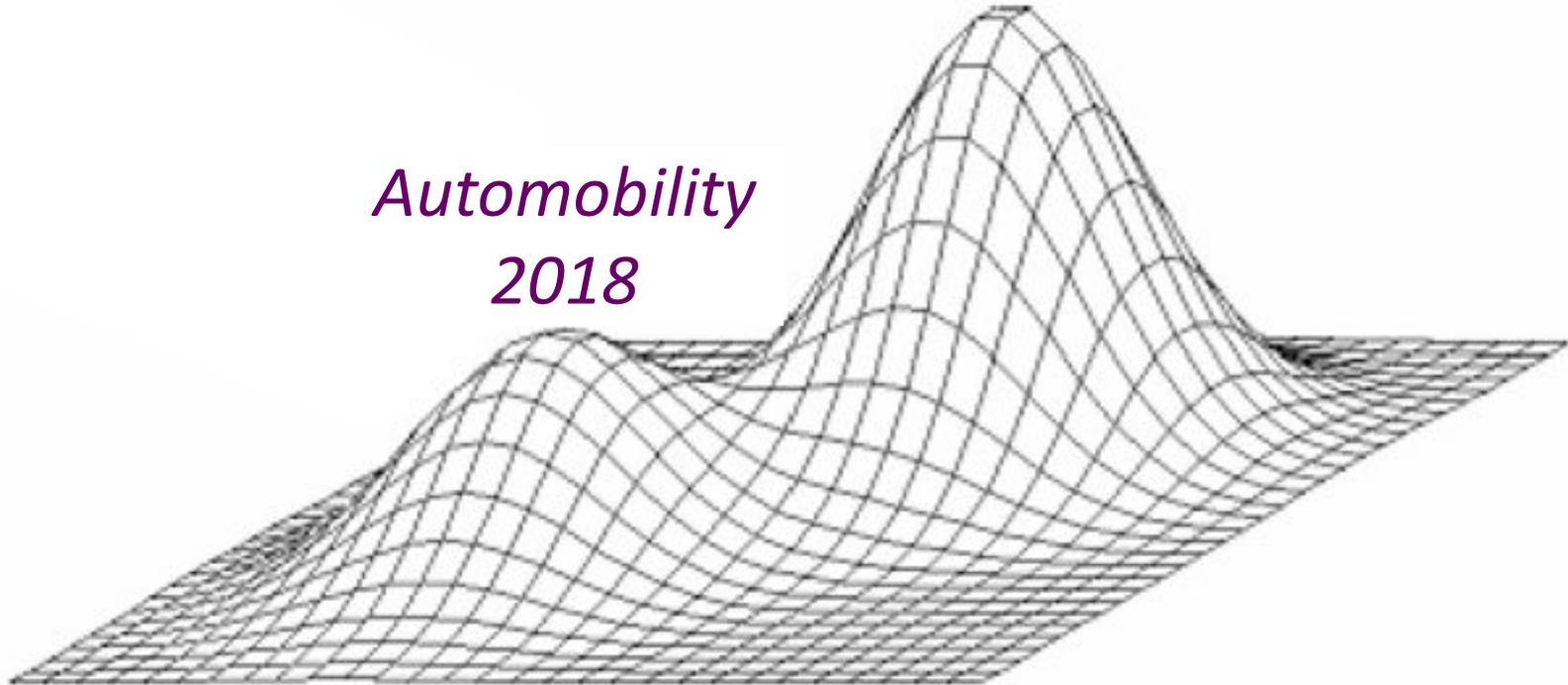
RESIDENTIAL AND  
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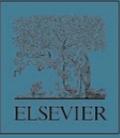
Constructing Ontario's Future



*Automated  
and Shared  
mid-century*

*Automobility  
2018*

A 3D wireframe landscape graphic consisting of a grid of lines that forms a series of hills and valleys, receding into the distance. The lines are black on a white background, creating a perspective effect.



# The End of Driving

Transportation Systems and  
Public Policy Planning for  
Autonomous Vehicles

Bern Grush • John Niles



# The End of Driving

1st Edition

Transportation Systems and Public Policy  
Planning for Autonomous Vehicles

☆☆☆☆☆ [Write a review](#)

**Authors:** Bern Grush, John Niles

**Paperback ISBN:** 9780128154519

**Imprint:** Elsevier

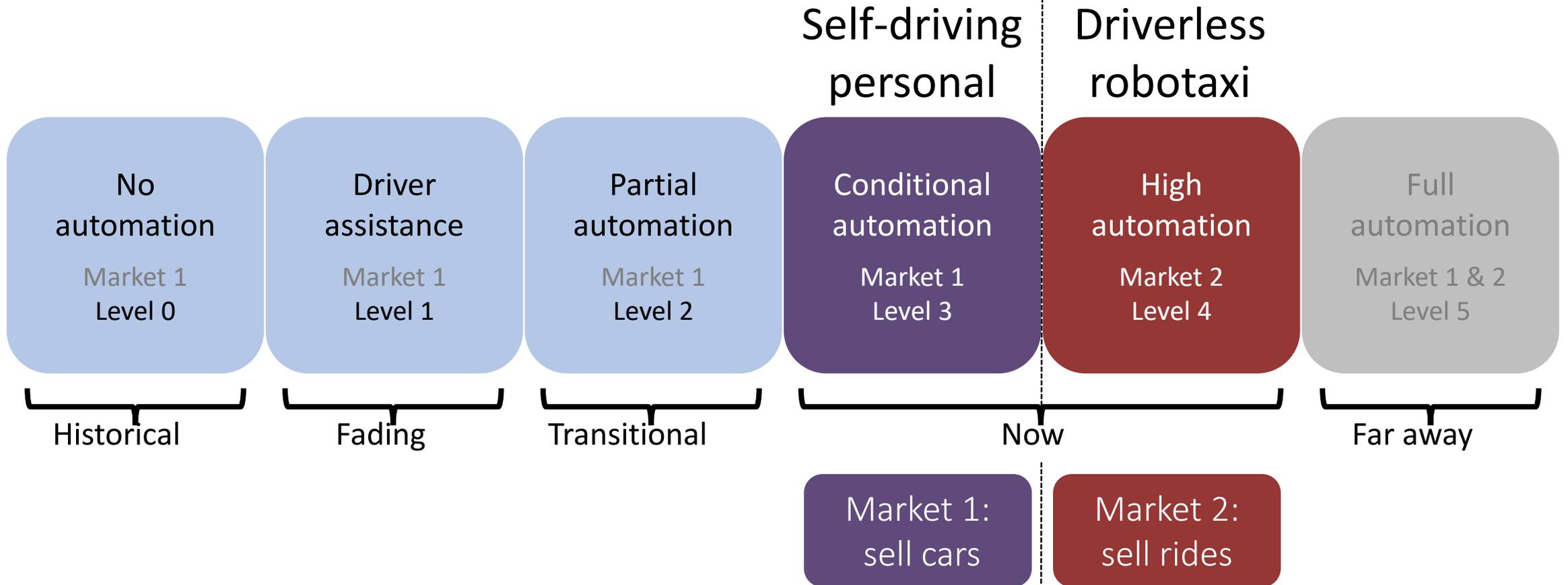
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**Code:** "ATR30"

# There are two markets for automation

(Only two SAE engineering levels really matter for now)



# Social impact of Market 1 — Sprawl



What happens to land-planning if AVs reduce the consumer pain of congestion?



Market 1:  
sell cars  
  
Personal  
automation

# Job reach (related to sprawl...)



Market 1:  
Personal  
automation



# Social impact of Market 2 — Transit

What happens when robotaxis cost the same as the bus?



What happens when robotaxis cost less than the bus?



Market 2:  
sell rides

Public  
automation

Autonomous vehicles will only help to meet public policy goals if they come as shared fleets integrated with public transport

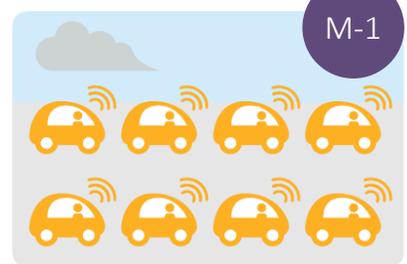


Autonomous vehicles

Shared fleet of vehicles

- + Strong reduction in number of cars (reduced car ownership, effective use of cars as they operate most time of the day)
- + Drastically improved mobility for people that do not own a car

Privately owned cars



- ⊖ No effect on car ownership
- ⊖ No effect on number of parked cars (cars unused most of the day)
- ⊖ No effects on costs /km
- ⊖ No effects on mobility for people that do not own a car
- ⊖ Even more car traffic (as it is even more comfortable and attractive to go by car)

> Unsustainable, even more car traffic

Fleet cars COMPETING with traditional public transport services



- + Street reclaiming (less parked cars)
- + Improved access to public transport
- + Improved mobility for people that do not own a car
- ⊖ More traffic (strong increase in Vehicle Miles Traveled - VMT)
- ⊖ Inefficiency (small vehicles replacing buses and trains)
- ⊖ Passenger loss for traditional public transport walking and cycling

> Better mobility, less efficiency

Fleet cars INTEGRATED with traditional public transport services



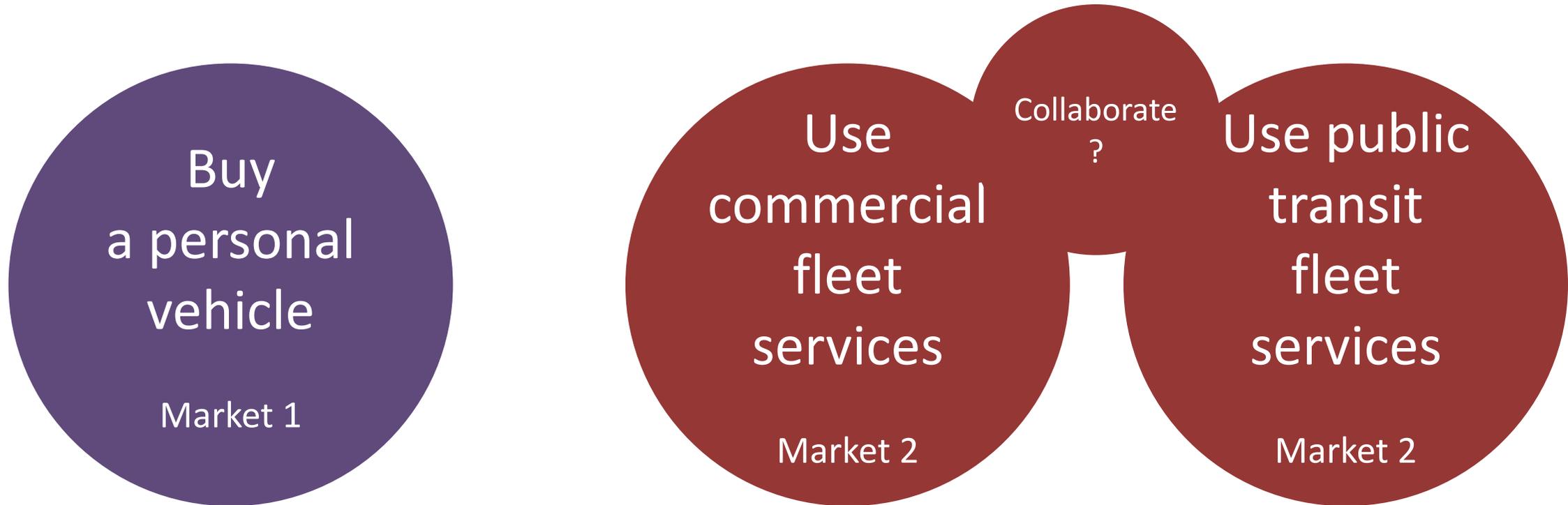
- + Large scale street reclaiming
- + Highly improved access to public transport
- + Highly improved mobility for people that do not own a car
- + Strong decrease in VMT
- + High gain of efficiency (large and small vehicles perfectly mixed)
- + Low costs/km

> Sustainable, better mobility and equity

# Market 2 has Two Outcomes

1. Commercial & competitive
  - Congested
  - Transit ridership falls
2. Harmonized & integrated
  - Optimizable
  - Heavy transit sustained

# Future of motorized automobility

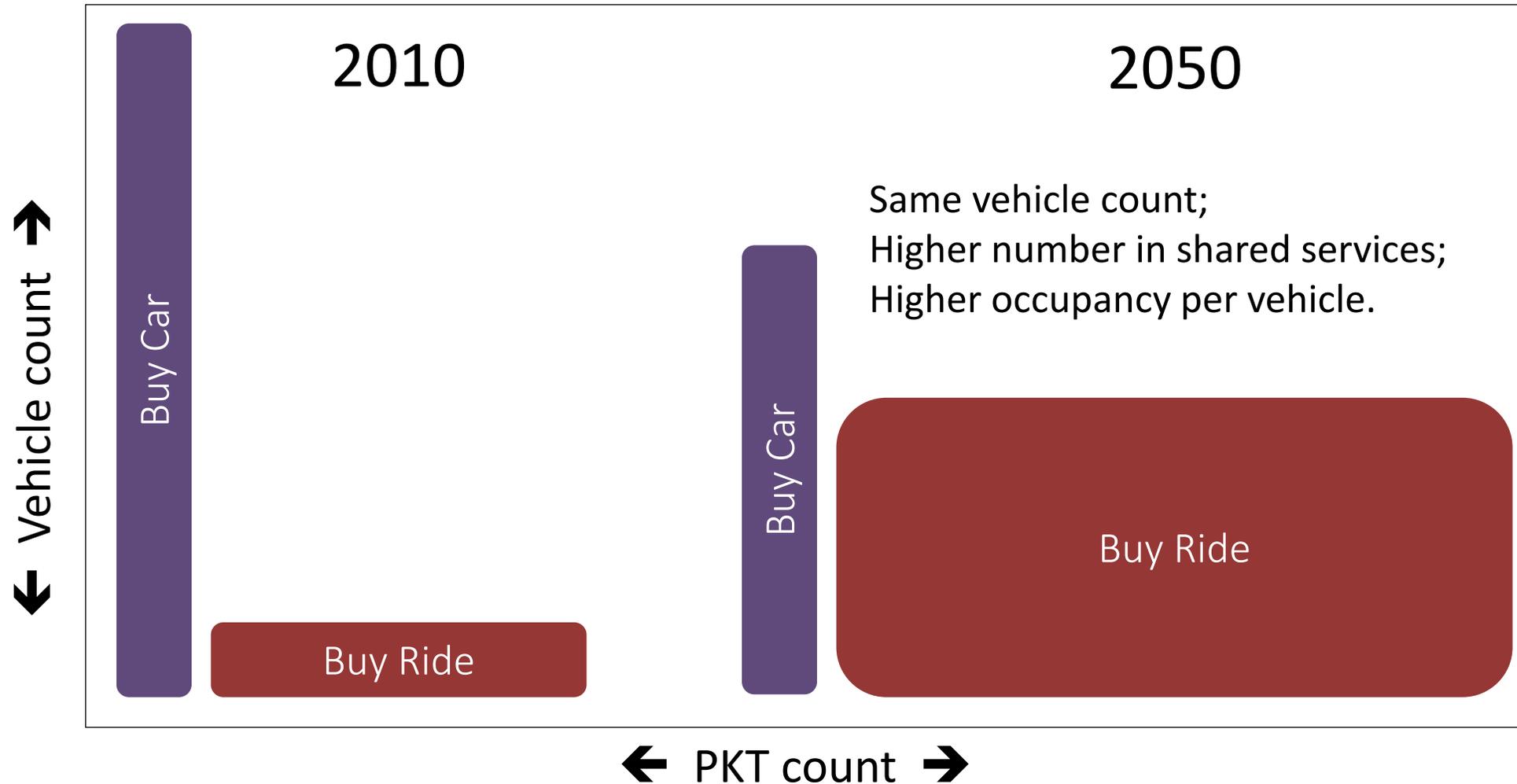


“...a war brewing ...between the automotive sector and the transit sector” re who will deliver shared-mobility, autonomous, electrified services.”

*Josipa Petrunic, Canadian Urban Transit Research and Innovation Consortium (CUTRIC)*

# PKT expected to grow 3x 2010-2050

Can we serve this with the same fleet size?



# Preparing for automated vehicle fleets

Acquire and operate?

Or Specify and regulate?

## Risk

Tech obsolescence  
Diffusion  
Outcome  
Timing  
Acceptance  
Costs  
Funding  
Mixed driving  
Resilience

## Scale

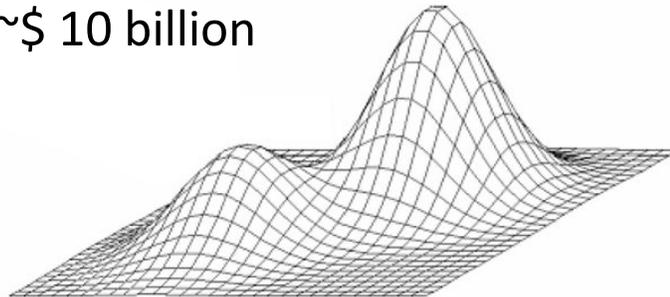
Affordable?  
  
150,000 vehicles  
to serve 25% of  
PKT demand in  
GTHA in 2030s  
  
~\$ 10 billion

## Flexibility

Achievable?  
  
Demanded by riders  
  
Hard to achieve with  
current transit  
mindset and metrics

## Competition

...for riders, roadspace,  
parking, funds  
  
...among public transit,  
commercial services  
and private cars  
  
Why compete?



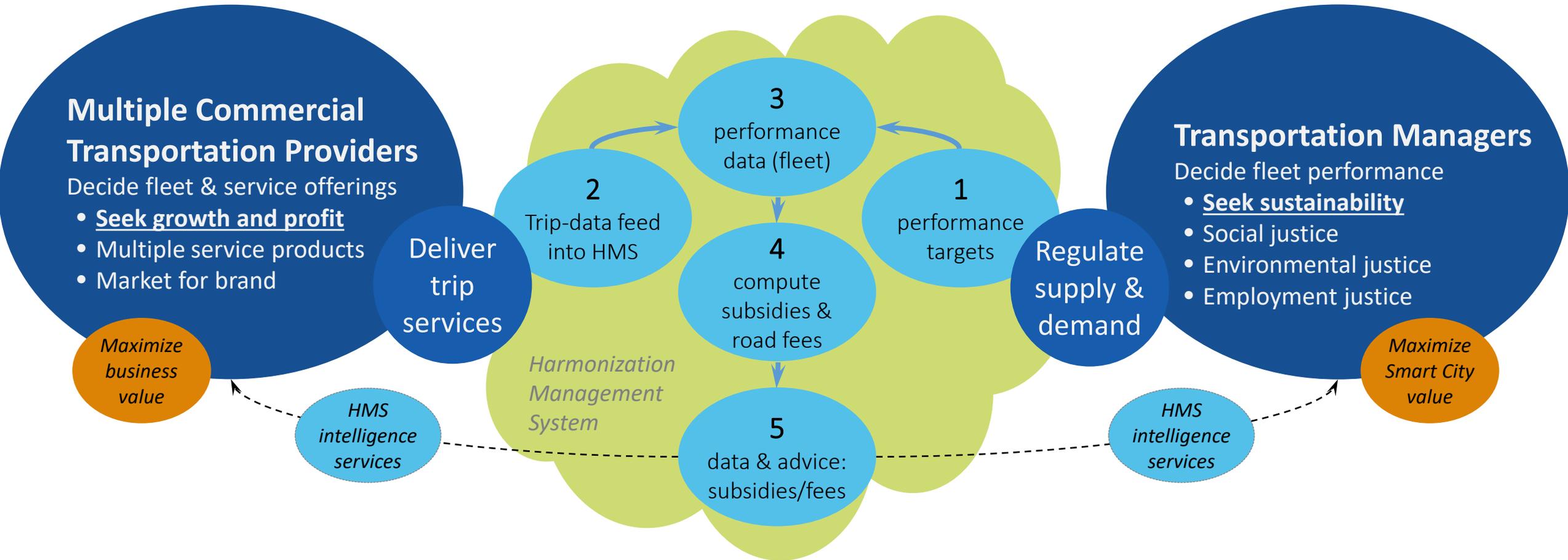
# Harmonization Management System



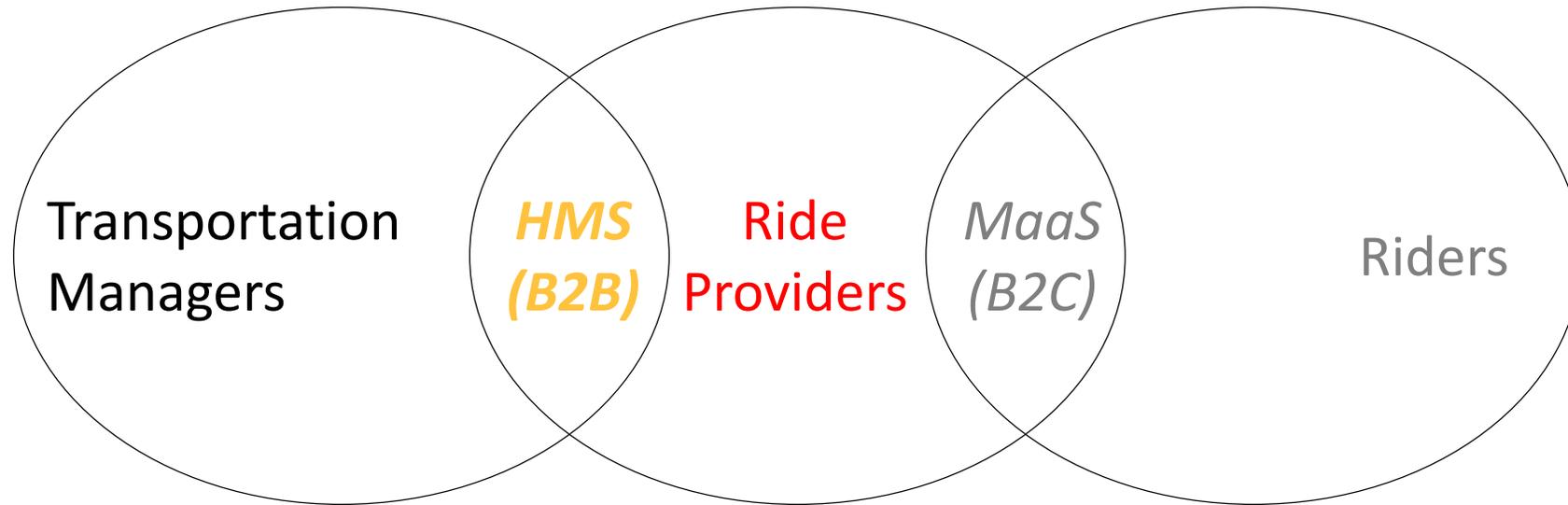
HMS is a software platform

Offers transportation demanders/managers the ability to specify and regulate commercial transportation supply in the digital transportation era.

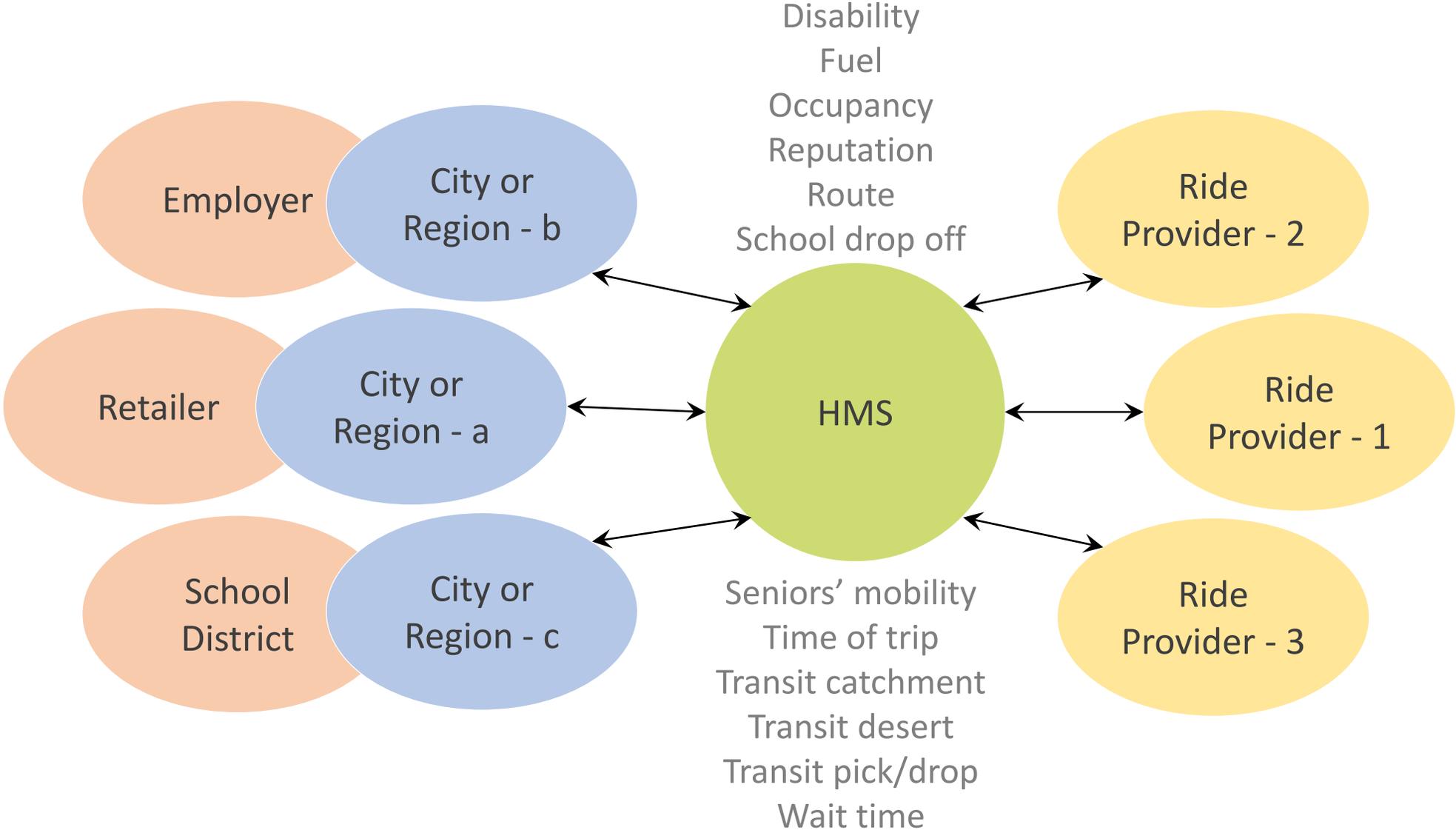
# Harmonization Process Flow



# HMS enables transportation managers to manage ride providers in the Platform Economy



# Many to many to many.



# Purpose of HMS

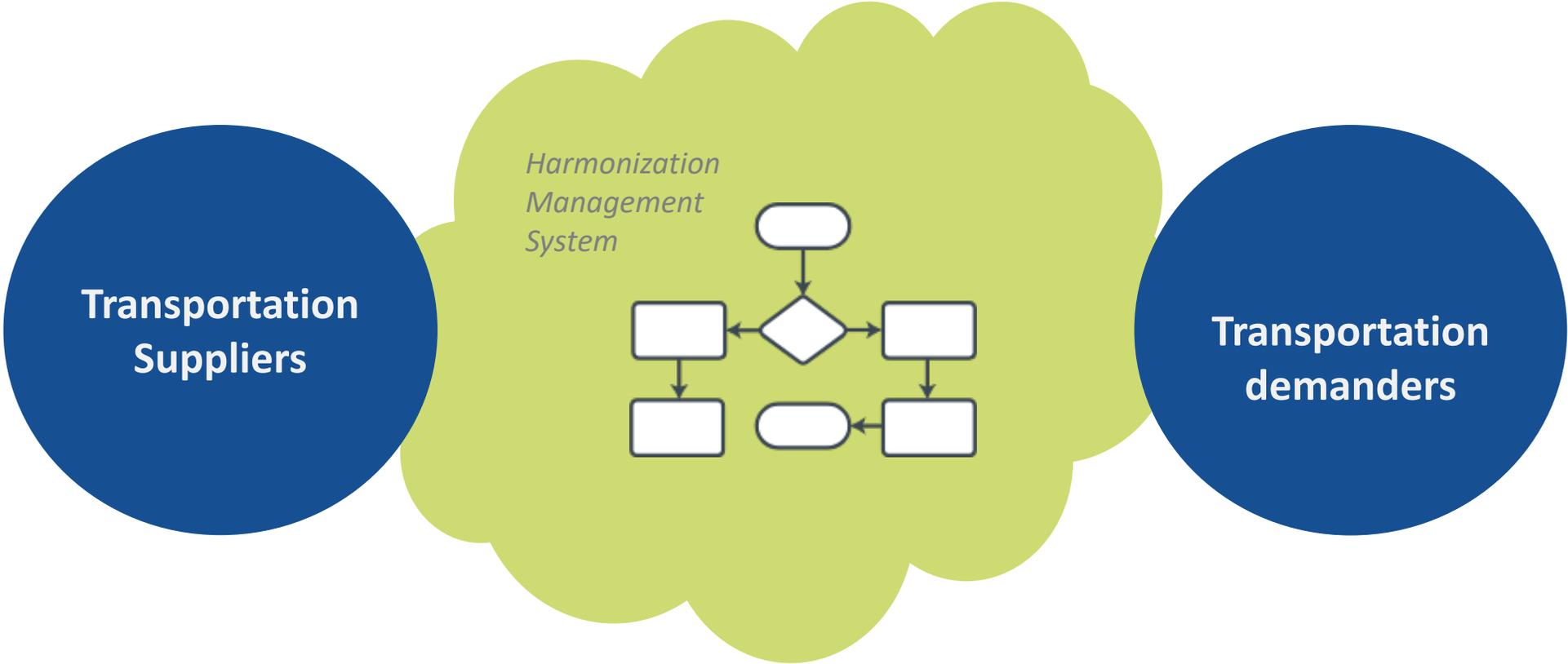


HMS: software platform

Offers transportation demanders/managers the ability to specify and regulate commercial transportation supply in the digital transportation era.

1. Specify transit performance requirements
2. Regulated by transportation managers
3. Set and manage subsidy budget (*road-use fee?*)
4. Open to all ride providers and services
5. Simplify procurement process
6. Service resilience
7. Coverage for social equity
8. Uniform analytics
9. Data-learning from other cities
10. Increases business opportunities

Thank you!



<b>Programs</b>
Maps
Ride Providers
Data
Legal



## Build a New Program

Back

Select the type of program you would like to create.

 <b>First-/Last-Mile</b> Support connections to transit hubs	 <b>Seniors Mobility</b> Support options for those who can no longer drive	 <b>Special Needs</b> Support for those who require assistance  Coming soon	 <b>Custom</b> Design a new program from scratch  Coming soon
---	---	--	--

Contract Name	<input type="text" value="Richmond Hill First-/Last-Mile"/>
Start Date	<input type="text" value="2018-05-01"/> 
End Date	<input type="text" value="2018-10-31"/> 
Total Budget Cap	\$ <input type="text" value="25,000"/>

Next

# Harmonization Management System

by  Harmonize MOBILITY

<b>Programs</b>
Maps
Ride Providers
Data
Legal



## Choose Location

Back

Select target and catchment areas to include.

Set Target Area

Set Catchment Area



*Note: Increasing target area will improve use, decreasing will improve accuracy. Increasing catchment area will improve use but can increase costs exponentially.*

Location Name

Richmond Hill Transit Station

Next

- Programs**
- Maps
- Ride Providers
- Data
- Legal



## Define Subsidy Limits and Amounts

Back

Enter eligibility criteria and incentive amounts.

**Limits**

Time of Day: Custom (dropdown) From: 6:30 AM To: 10:00 AM

Days of Week: Custom (dropdown) Sun:  Mon:  Tue:  Wed:  Thu:  Fri:  Sat:

Trip Distance: Any (dropdown)

Occupancy: Any (dropdown)

**Amounts**

*Suggested subsidy amounts from our UTTRI modeling partnership:*

Fixed credit per ride: \$ 5.00 (input) \$5.00

Credit per kilometer: \$ 0.15 (input) \$0.15

*Example: With a fixed credit of \$5.00 and a per kilometer credit of \$.15, a three-kilometer ride would receive \$5.00 plus 3 x \$.15 (\$.45) for a total of \$5.45.*

Next

- Programs**
- Maps
- Ride Providers
- Data
- Legal



## Review Program

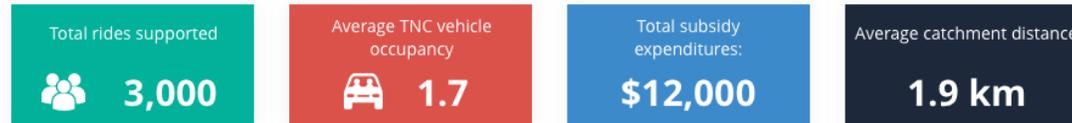
[Back](#)

Verify program details and estimated outcome.

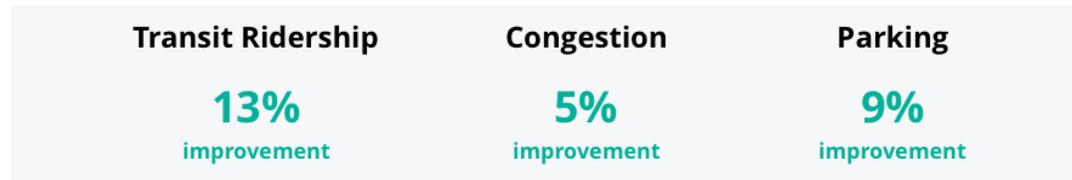
<b>Program Name</b>	Richmond Hill First-/Last-Mile	<b>Location</b>	Richmond Hill Transit Station
<b>Total Budget Cap</b>	\$25,000	<b>Additional Limits</b>	None
<b>Program Dates</b>	May 1 2018 to Oct 31 2018	<b>Subsidy Amount</b>	\$5.00 + \$.15/km

### Estimated Results

*Estimations derived from our UTRI modeling partnership*



### Estimated Impacts



[Submit Program](#)

- Programs**
- Maps
- Ride Providers
- Data
- Legal



## Program Outcome Report

[Back](#)

Completed program.

<b>Program Name</b>	Oakville Seniors Pilot Project	<b>Location</b>	Oakville City Centre
<b>Total Budget Cap</b>	\$150,000	<b>Additional Limits</b>	Age (65+), Licence (No Licence)
<b>Program Dates</b>	Aug 1 2018 to Jul 31 2019	<b>Subsidy Amount</b>	\$5.00 + \$.15/km

### Program Results

	Total rides supported  <b>13,281</b>	Average TNC vehicle occupancy  <b>1.2</b>	Total subsidy expenditures: <b>\$114,089</b>	Average catchment distance <b>2.2 km</b>
<b>Uber</b>	5,765	1.6	\$8,943	2.5 km
<b>Lyft</b>	3,988	1.6	\$4,011	2.2 km
<b>FaceDrive</b>	902	1.1	\$409	1.3 km
<b>InstaRyde</b>	1,254	1.2	\$833	0.8 km
<b>Taxify</b>	1,172	1.5	\$645	1.7 km

### Program Impacts

<b>Residents Served</b> <span style="font-size: 1.5em; color: #00c090;">+ 13%</span>	<b>Accident Rate</b> <span style="font-size: 1.5em; color: #00c090;">- 5%</span>	<b>Parking</b> <span style="font-size: 1.5em; color: #00c090;">- 2%</span>																											
<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"></td> <td style="width: 10%; text-align: center;"><i>Estimate</i></td> <td style="width: 60%;"></td> </tr> <tr> <td>Seniors with access</td> <td style="text-align: center;">1651</td> <td style="text-align: center;">1576</td> </tr> <tr> <td>Unlicensed ratio</td> <td style="text-align: center;">61%</td> <td style="text-align: center;">63%</td> </tr> </table>		<i>Estimate</i>		Seniors with access	1651	1576	Unlicensed ratio	61%	63%	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"></td> <td style="width: 10%; text-align: center;"><i>Estimate</i></td> <td style="width: 60%;"></td> </tr> <tr> <td>Road accidents / month</td> <td style="text-align: center;">84</td> <td style="text-align: center;">1085</td> </tr> <tr> <td>Percent involving seniors</td> <td style="text-align: center;">7</td> <td style="text-align: center;">14</td> </tr> </table>		<i>Estimate</i>		Road accidents / month	84	1085	Percent involving seniors	7	14	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"></td> <td style="width: 10%; text-align: center;"><i>Estimate</i></td> <td style="width: 60%;"></td> </tr> <tr> <td>Parking capacity filled</td> <td style="text-align: center;">88%</td> <td style="text-align: center;">98%</td> </tr> <tr> <td>Curbside dropoff ratio</td> <td style="text-align: center;">1:5</td> <td style="text-align: center;">1:3</td> </tr> </table>		<i>Estimate</i>		Parking capacity filled	88%	98%	Curbside dropoff ratio	1:5	1:3
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**Table 1: A Rough Calculation of Expected Fleet Size, Estimated Costs to Service 25% of the GTHA PKT with Robo-Vehicles Circa 2030**

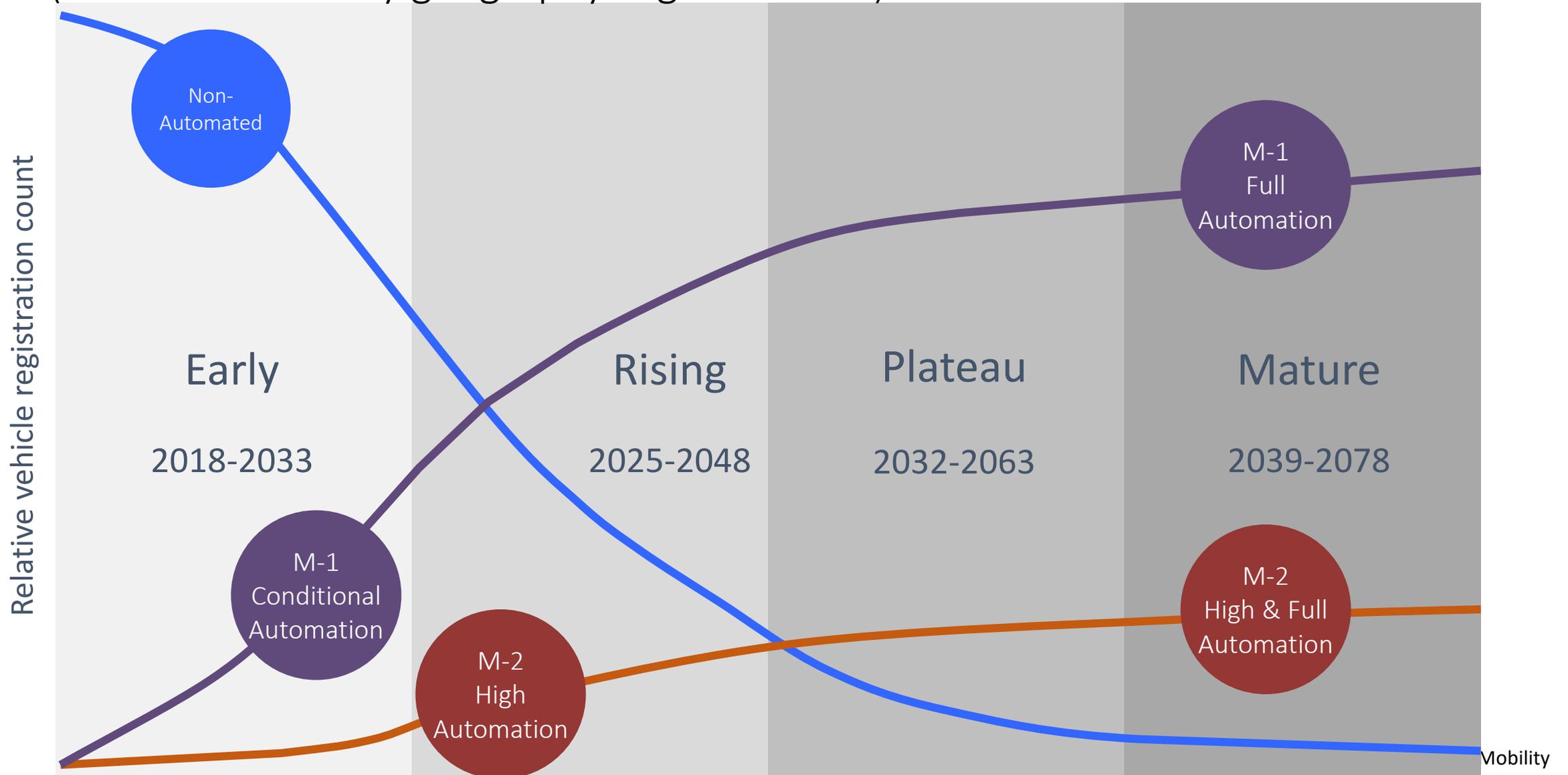
GTHA population 2030 (projected)	8.5 M
25 percent of pop (Roland Berger suggested 27% of PKT in robo taxis)	2.125 M
Annual PKT per person (less than current U.S. 13,500 VKT to be conservative for ride-buyers, assume ride buyers purchase fewer km than car-owners travel)	12,000
Total annual PKT for 25%	25.5 B
Current per vehicle occupancy (in passenger vehicle (U.S.))	1.59
Total annual VKT for the 25% at this (current) occupancy	16 B
Target occupancy (mixture of 2-, 4-, 6-, and 12-person vehicles comprising 50, 25, 20 and five percent of the fleet respectively, and operating on average at 50% occupancy (including deadheading which means 55% occupancy when occupied if deadheading is at 10%))	2
Total annual VKT (by converting PKT to VKT at the target occupancy)	12.75 B
Daily duty hours of a vehicle (estimated: daily work cycle including deadheading and waiting for riders; excludes charging, parking when not in use)	16
Speed km/h, <i>estimated from current transit ~2015</i> (top vehicle speed is the posted speed, but most actual travel is in-city, with traffic stops, pickups, waiting, heavy traffic, lights, etc);	24
Daily km potential: all in, stops, pickups, top speed, etc. (duty cycle x speed)	384
Annual km (daily km x 365)   (This may be high at first, so larger relative fleet may be needed at start ...)	140,160
NYC taxi annual (for comparison only; this indicates that 140,160 is only slightly high, since robo vehicles are more optimized than human-driven)	112,000

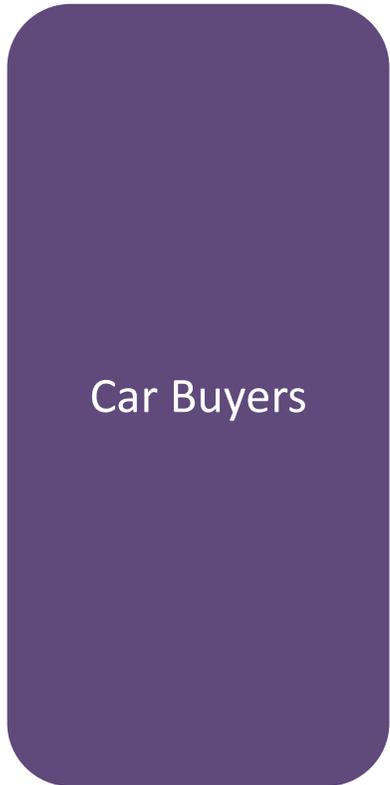
Annual km (daily km x 365)   (This may be high at first, so larger relative fleet may be needed at start ...)	140,160
NYC taxi annual (for comparison only; this indicates that 140,160 is only slightly high, since robo vehicles are more optimized than human-driven)	112,000
<b>Floor</b> estimate: Number vehicles to cover total VKT; assume perfect operation, average day	91,000
<b>Ceiling</b> estimate: assume 15% (of the ride-buying 25%) of the population is in a vehicle at the annual peak hour, the fleet would need to serve 3.75% of the population concurrently	159,000
<b>Peak-to-Average</b> estimate: use 1.6 x <b>floor</b> [Sweet] requires 146,000 vehicles. (The factor of 1.6 was taken from a traffic study of the Toronto area (this accounts for annual or weekly peaks, not the annual peak!))	146,000
<b>Calculated</b> estimate: the average between the <b>ceiling</b> and the <b>peak-to-average</b> . Such a fleet might incur slightly longer queues at some annual peaks (Christmas shopping, Halloween night) but would have spare capacity to meet short-wait promises, otherwise ( <b>Note:</b> <i>there is no buffer for vehicle failures or scheduling and distributions shortcomings.</i> )	152,000
Average annual vehicle cost (capex+ opex+ 0.2FTE @ 80K) * * Assume Capex and Opex (excluding staff costs) for a vehicle is \$50,000 per annum including support equipment. Assume fleet operations (fuel/energy, management, payment systems, security, police and emergency, maintenance (repairs and cleaning), oversight, stewards on the minibuses, map maintenance, roadway watchdogs) require 1 FTE per 5 vehicles. Average staff salary and overhead per FTE is \$80,000 per annum, or \$16,000 staff expense per vehicle (30,500 jobs for a fleet of 152,000).	\$66,000
Total annual cost given above peak, but no buffer; implies occasional waiting times	\$10.1 B
Cost per PKT (no contingency, no profit)	\$0.39



# AV-Eras

(Diffusion varies by geography & governance)





now



early automation  
2020s  
(evidence? "History")



planner's stated preference  
2030s-2040  
(evidence? "Hope")

