

# Perspectives on Vehicle Automation

John Niles, Partner, Grush Niles Strategic  
Co-author, *The End of Driving*

Presentation to Washington State Transportation Commission, December 17, 2019

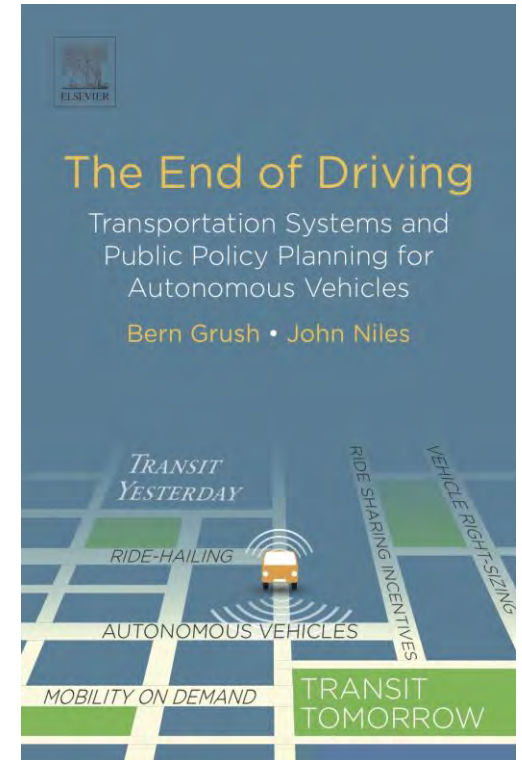


# *The End of Driving: Transportation Systems and Public Policy Planning for Autonomous Vehicles*

by Bern Grush and John Niles

**Interrelated SYSTEMS of ECONOMICS, HUMANS, CITIES, PLANNING, and BUILT FORM interact as states and communities react to and plan for vehicle automation**

- Graduate level textbook aimed at metropolitan planning agencies and public transit agencies
- Covers far-reaching human, social, and urban issues more than transient technical or vehicle issues
- 15 Chapters with exercises



Categories:  
Social Science, Transportation



# What will AVs be when they grow up?



Immersive social interfaces — a new type of living space on wheels?



Isolated people pods like today's SOVs but on a couch?



A people-mover workhorse, part of a flexible mass transit ?



# Utopia vs. Dystopia





# 1890: Save us from horses!



Fatalities  
Injuries  
Carcasses  
Typhus  
Flies  
Manure  
Smell  
Urine

The Great Horse  
Manure Crisis 1894



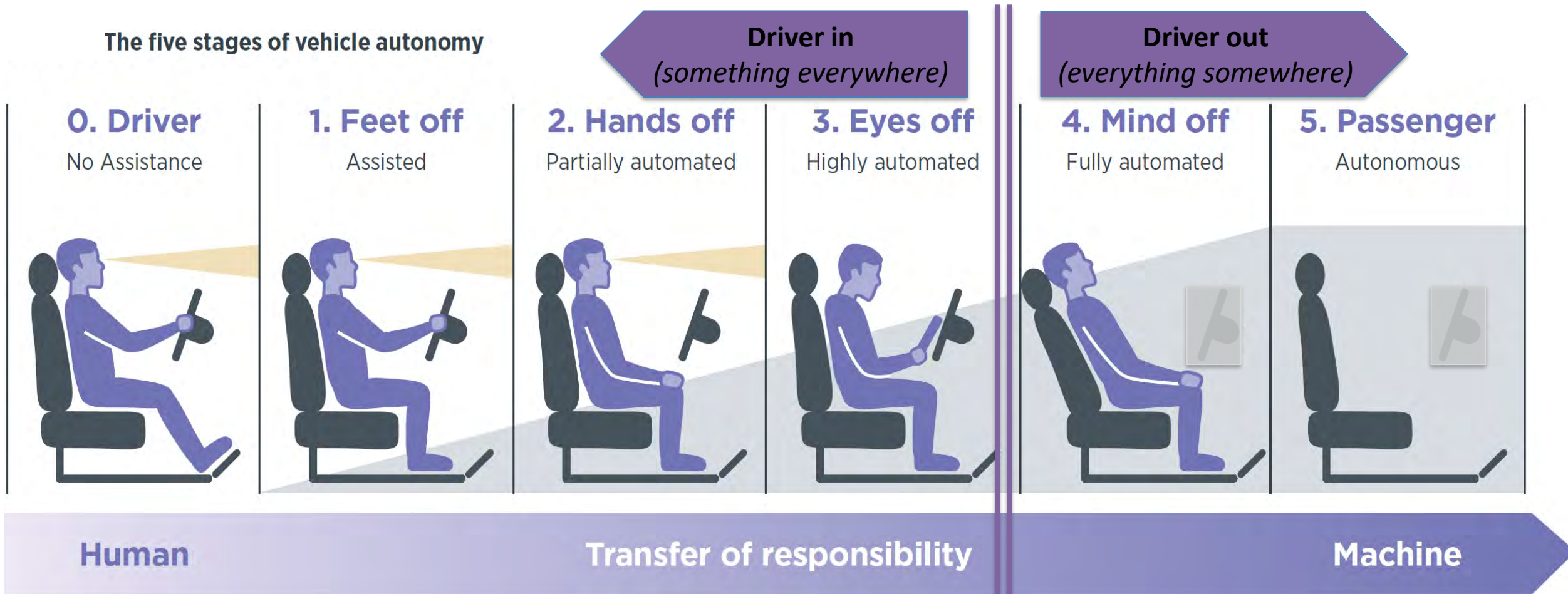
# 2010: Save us from cars!



Injuries  
Fatalities  
Health  
Pollution  
GHG  
Congestion  
Sprawl  
Inequity  
Habitat loss



# Simplistic Market Buzz Since 2013

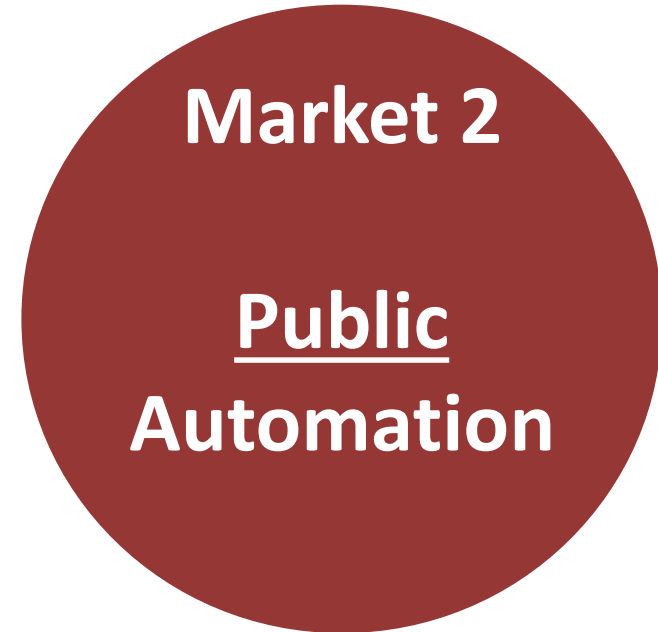




# Two Kinds of Automated Vehicles are Happening



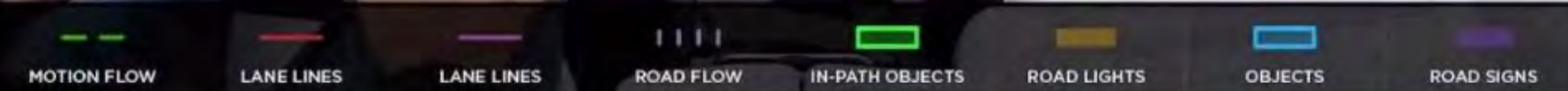
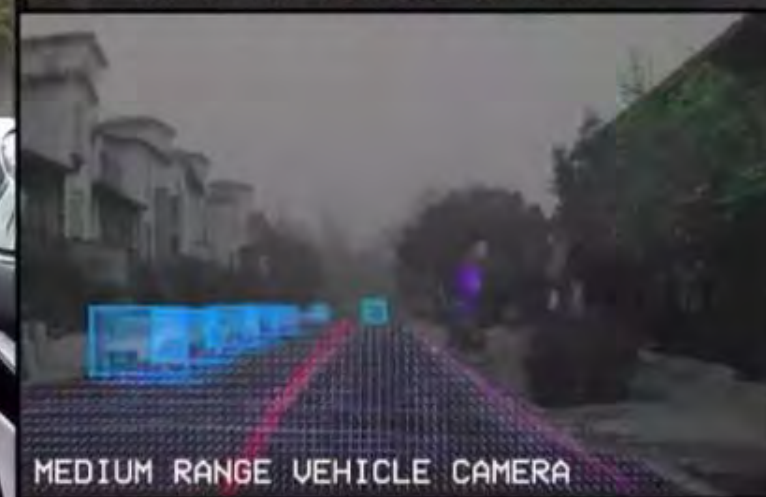
People buying CARS



People buying RIDES



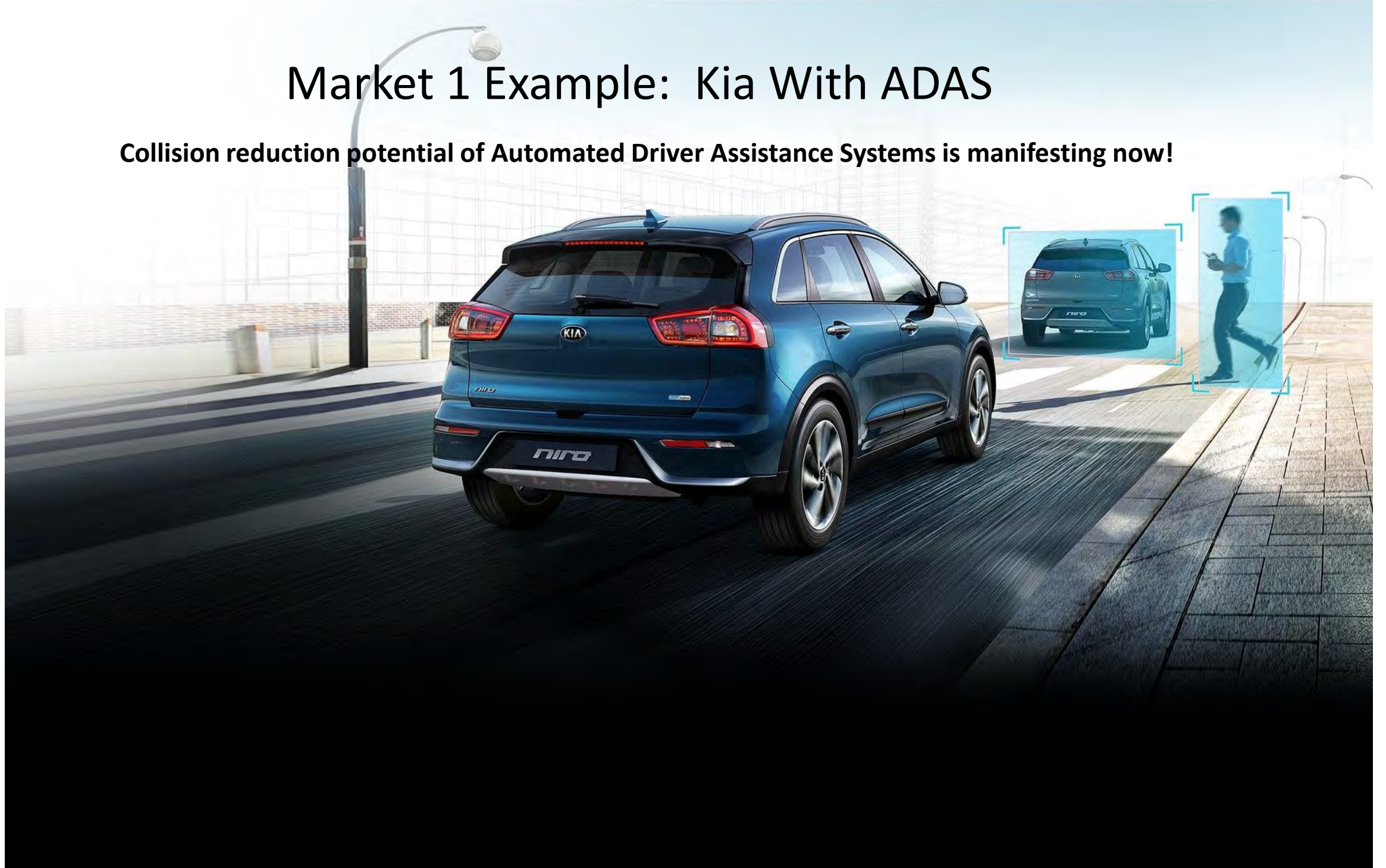
# Market 1 Example, Tesla





# Market 1 Example: Kia With ADAS

**Collision reduction potential of Automated Driver Assistance Systems is manifesting now!**





# User's personal view ...

L2  
Partial  
(personal)  
Hands-On

L3  
Conditional  
(personal)  
Self-driving

Market 1

Market 2

L4  
High  
(robotaxi)  
Driverless

L5  
Full  
2075  
or  
later





# Autonomy vs Automation

- Autonomously Operating Features
  - ABS brakes
  - Electronic stability control
  - Air bag deployment
  - Forward collision warning
  - Automated parallel parking
  - Automated diagonal parking
  - Radar-activated braking
  - Parking sensors
  - Generally, ADAS
- Automated Cars, but Not Autonomous
  - Licensed operator-supervised highway driving in a Tesla, Cadillac, Mercedes, or other equipped vehicle.
  - Moving safely within a geo-fenced, fully-mapped urban zone between an origin and a destination as selected by a person.
  - Robotic vehicle control, commanded from a passenger seat, or from a remote location.



# Toughest Problem – Transition from Distraction to Driving





**Driver  
assistance  
L2/L3  
evolution to  
L4/L5  
automation  
does not yet  
have a clear  
path to  
achievement.**

## **Tesla on Autopilot collided Saturday morning with a state police cruiser**



By [Peter Marteka](#)  
Hartford Courant |  
Dec 07, 2019 | 11:05 AM



A state police cruiser was rear-ended by a Tesla on auto-pilot early Saturday morning. (Connecticut State Police)

A Tesla in Autopilot mode collided with a state police cruiser early Saturday morning as the trooper was assisting a disabled motor vehicle in the center lane of Interstate 95.



**3. Eyes off**  
Highly automated



How automated L3 vehicle operation is being designed:

- >>> problem ahead
- >>> Take Over Request (TOR) from the vehicle to the vehicle operator
- >>> Operator reacts
- >>> Operator gains situational awareness
- >>> Operator regains control of the vehicle to get through the problem
- >>> Operator restarts automation and the trip continues

## Improving Take-Over Quality in Automated Driving By Interrupting Non-Driving Tasks

Thomas Köhn  
Matthias Gottlieb  
Chair for Information Systems  
Technical University of Munich  
Munich, Germany  
{thomas.koehn|gottlieb}@in.tum.de

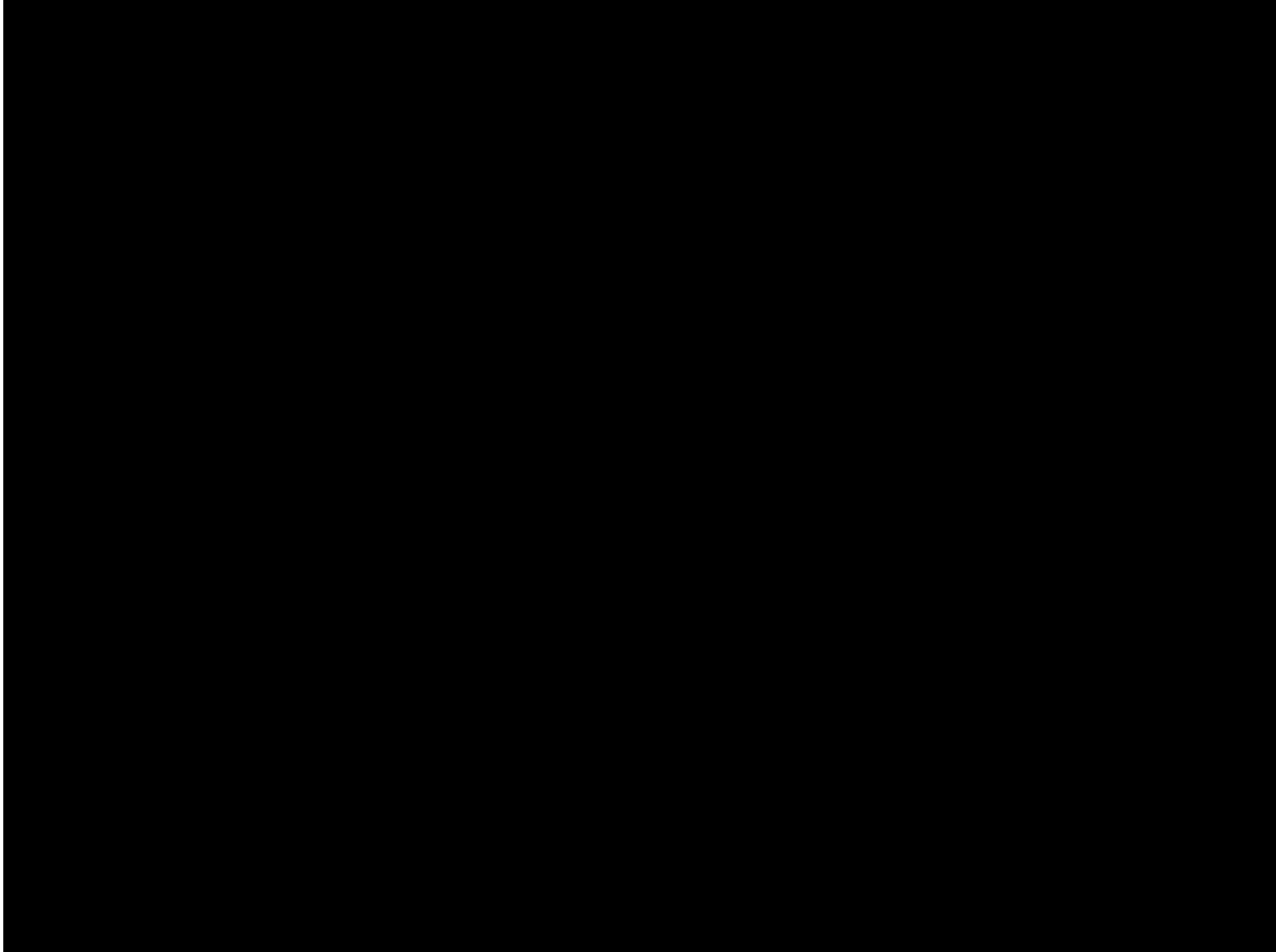
Michael Schermann  
Santa Clara University  
Santa Clara, CA, United States  
mschermann@scu.edu

Helmut Krcmar  
Chair for Information Systems  
Technical University of Munich  
Munich, Germany  
krcmar@in.tum.de

### Research Result:

**Certain kinds of operator distraction enhance safety, AND periodically interrupting the distraction to maintain operator mindfulness make this style of driving even safer.**







# Market 2 – Ride Buying







## Market 2 – Ride Buying



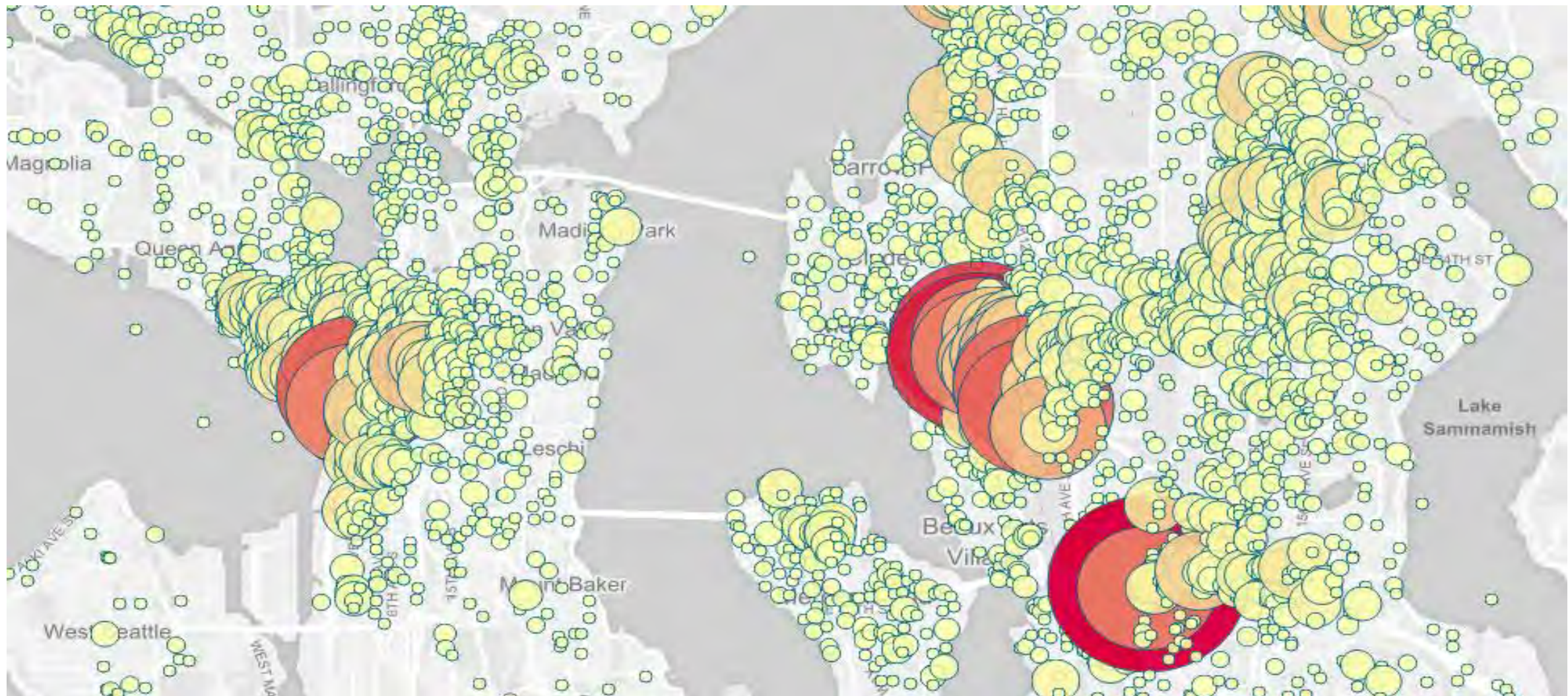
## Market 2 – Ride Buying





# Robo-CAB travel will be like Uber trips without a human driver

## Sample of recent Uber trip origins in Seattle Bellevue region





# Recap: Market 1 and Market 2

		Can go anywhere/anytime	
		Yes	No
Needs a human driver	Yes	Level 2-3 <b>Market 1</b> Self-driving: Can go anywhere if you drive	
	No	Level 5 <b>Far future</b> 2050-2075 +	Level 4 <b>Market 2</b> Driverless: constrained to a few prepared places and routes



# TRI Autonomy Software: One System, Two Modes



**GUARDIAN**



**TOYOTA**  
RESEARCH INSTITUTE



**CHAUFFEUR**



# Ford Sees Opportunity Selling Both Cars & Rides

*These new businesses bring new revenue*

**\$5.4**  
Trillion



**\$2.3**  
Trillion



Traditional Auto



Transportation Services



# Will ride-buying dominate?

Person Miles  
Traveled (PMT)  
in Personal Vehicles

M-1 PMT

M-1 PMT

M-1 PMT

M-2 PMT

Person Miles  
Traveled (PMT)  
using Ride Services

M-2 PMT

M-2 PMT

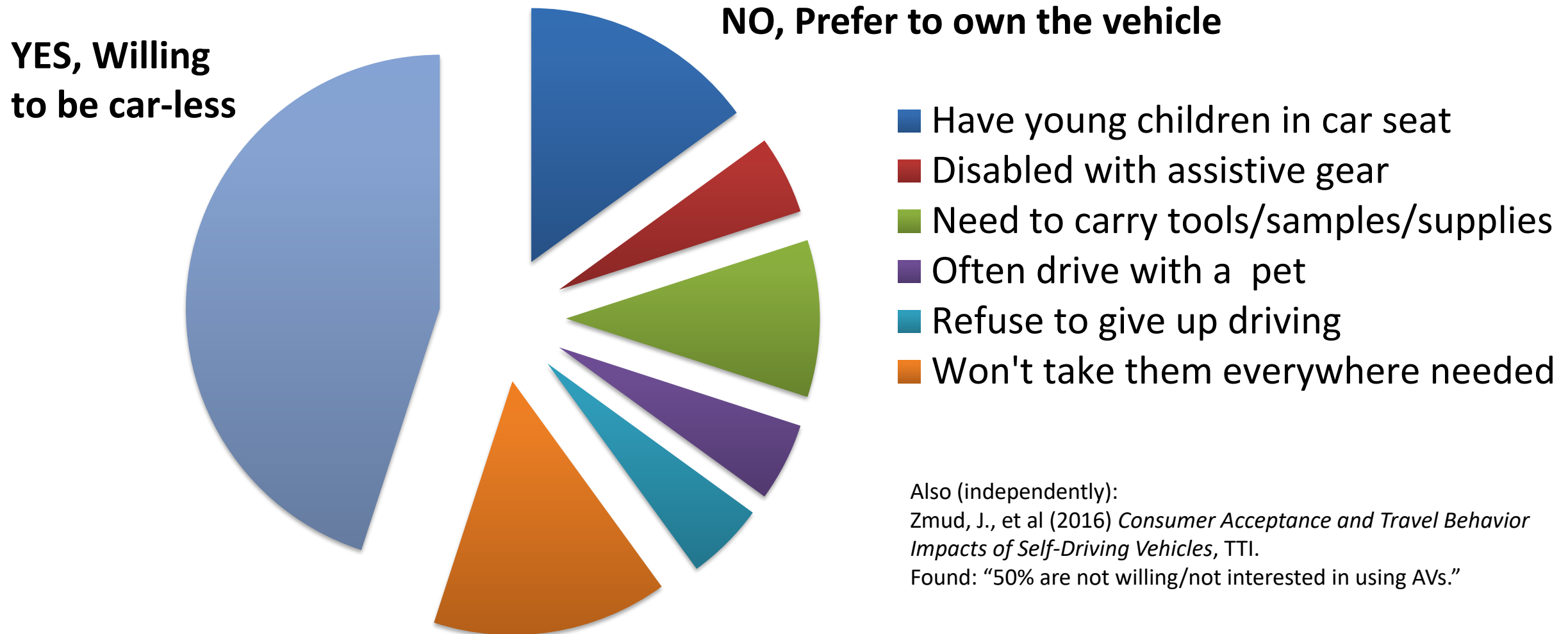
now

early automation  
early 2020s

possible future  
2030s-2040  
*(no evidence for this...)*



# Willing to give up owing a vehicle?





# Different efficiencies

Market 1

Revealed preference of  
Travelers/commuters

Market 2

Stated preference of  
urban/transit planners

*These are statistical realities, not moral judgments*



# What if a personal AV costs 25% of today's car?

## Cost of Driverless Vehicles to Drop Dramatically: Delphi CEO

By Paul Lienert | December 5, 2017



... current estimates for the cost of a self-driving hardware and software package range from \$70,000 to \$150,000, “the cost of that autonomous driving stack by 2025 will come down to **about \$5,000 because of technology developments and (higher) volume.**”

— Kevin Clark, CEO, Delphi Automotive

<https://www.insurancejournal.com/news/national/2017/12/05/473134.htm>



# **Will car sharing and ride sharing preserve these features of automobile ownership that make it so popular?**

- On-demand, near instant availability
- Controlled, flexible routing & stops
- Controlled, flexible start & arrival times
- Door-to-door, any origin, any destination
- Private, customized space while traveling
- Perceived safety & security
- Protection from heat, cold & rain/snow
- Ease of bringing family, friends, & cargo
- Emotional sensations - control, style, wealth

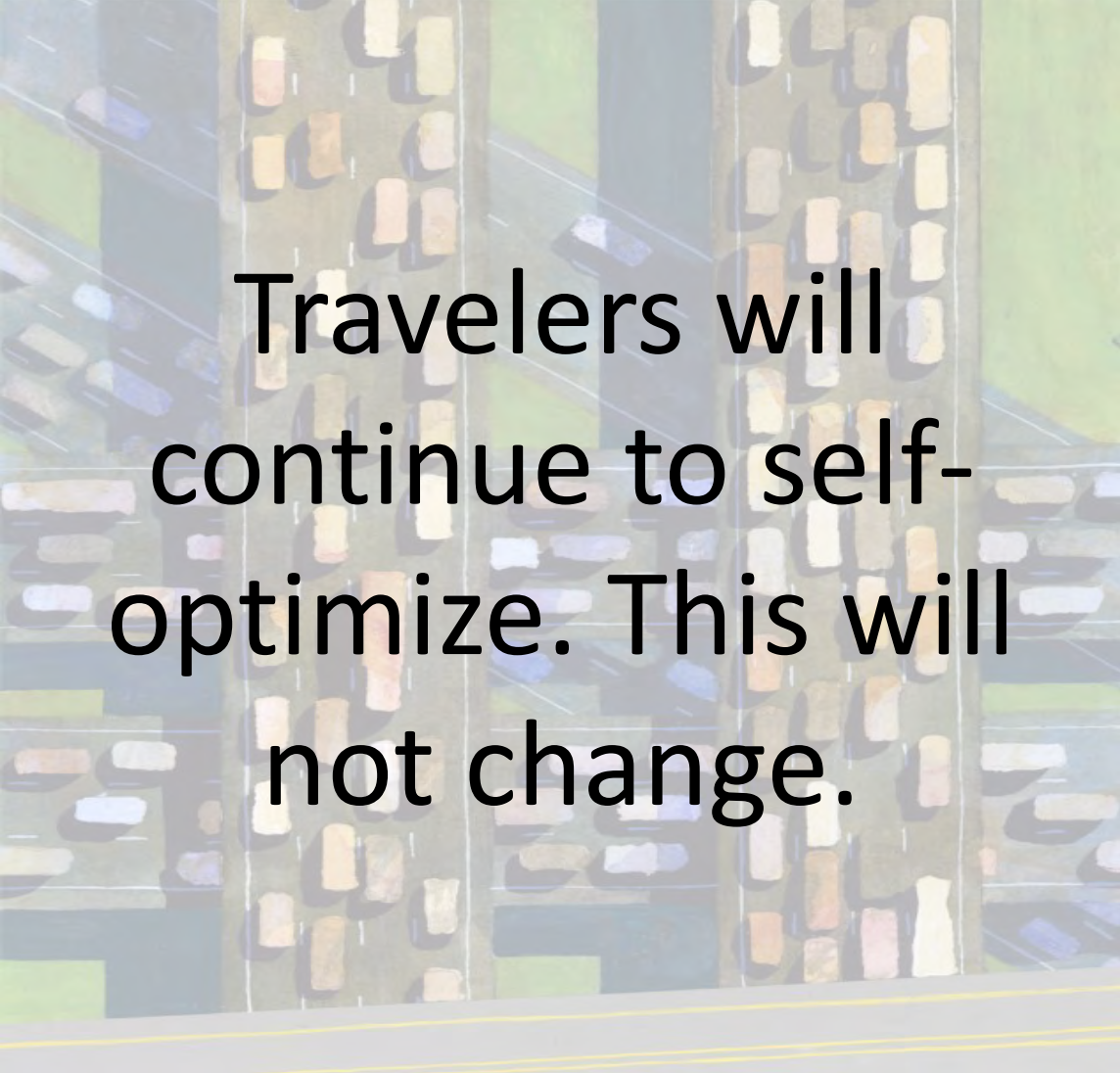


**Could Market 1 personal cars with ADAS and Internet connectivity  
be safe, energy efficient, small, inexpensive, and very popular?**





# Will we share cars or continue owning them?



Travelers will  
continue to self-  
optimize. This will  
not change.

☒ Yes

☒ No

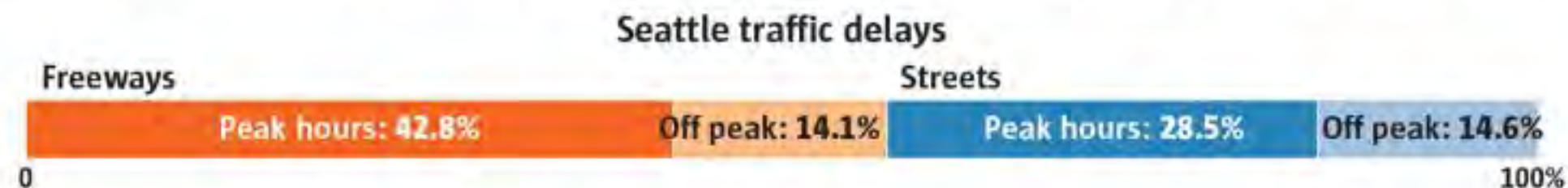
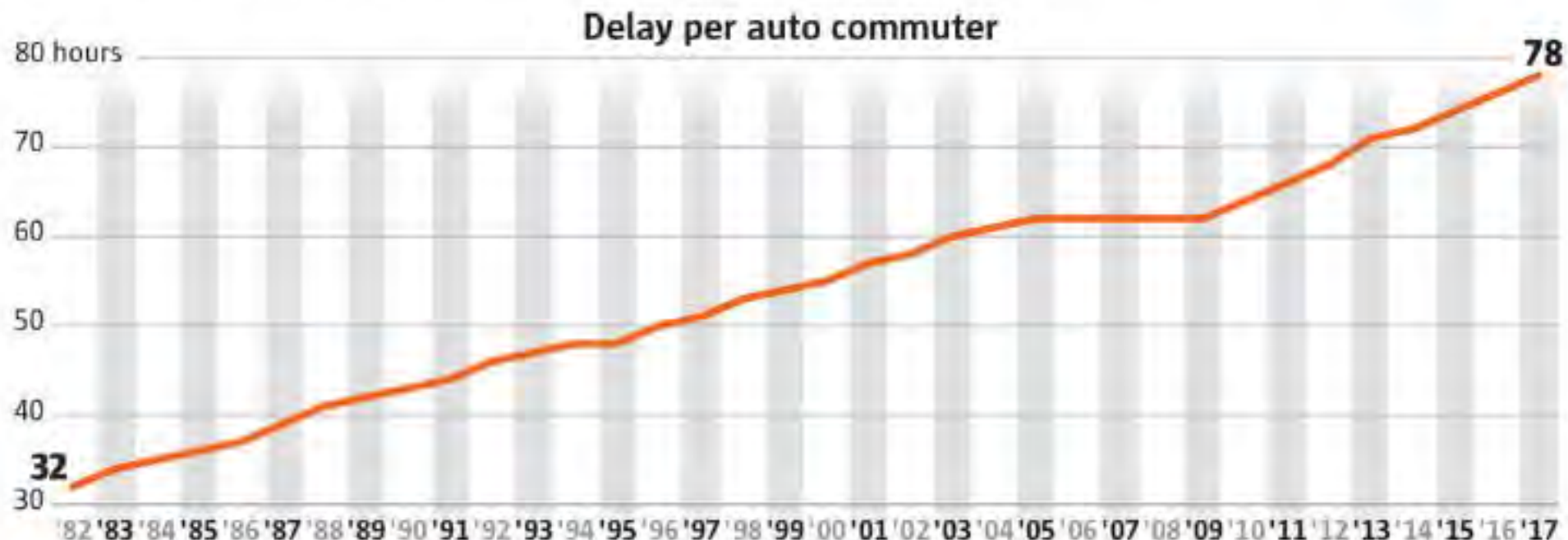
☒ It depends

☒ Each person decides. We live  
in a democracy.



## Seattle congestion over time

Texas A&M University has data on cities' traffic congestion going back to at least 1982. In 2017, the most recent year for which data is available, Seattle drivers spent an average of 78 hours sitting in traffic, a record for the city in this annual study.

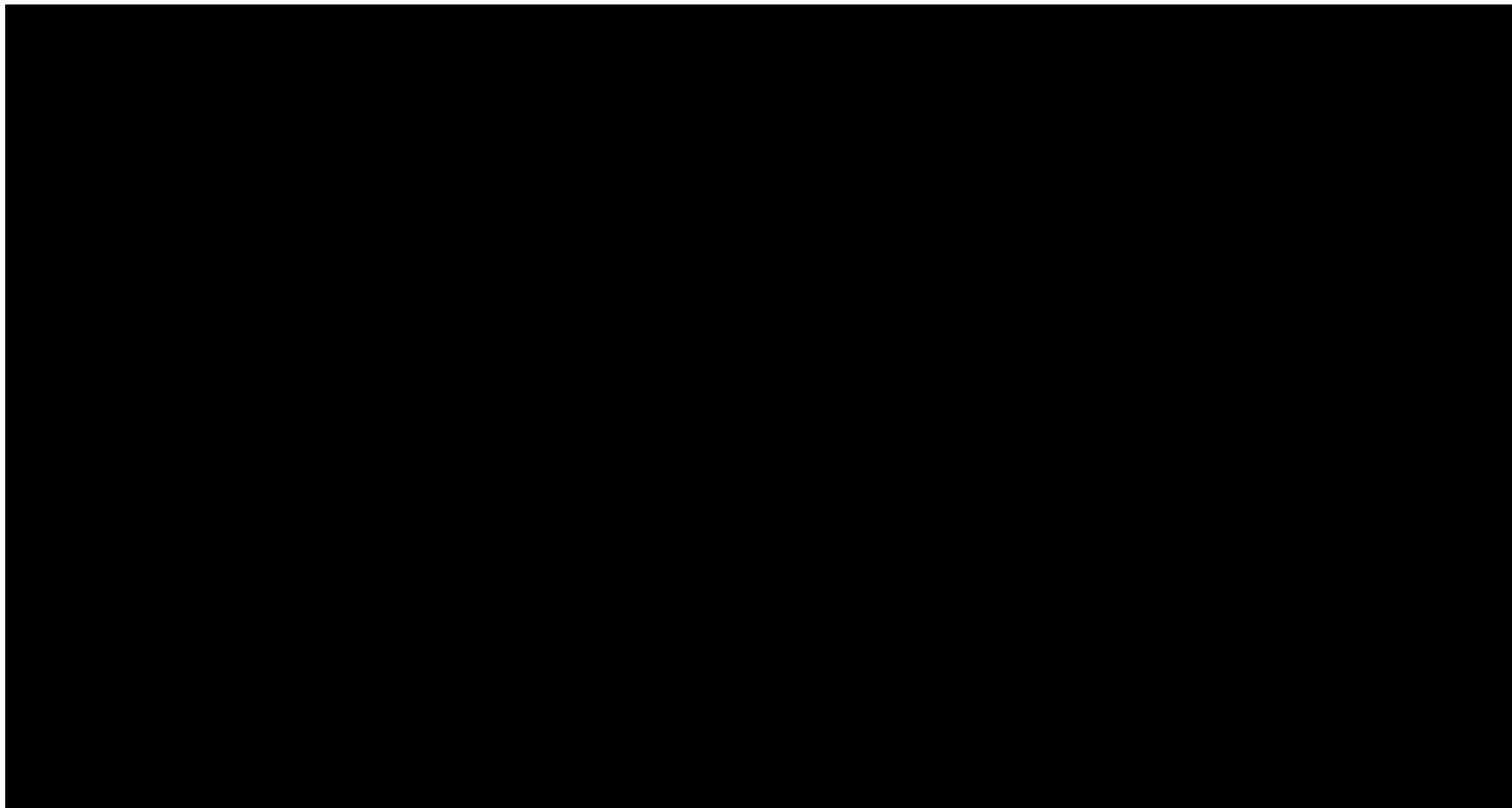


Source: Texas A&M University Urban Mobility Report

MARK NOWLIN / THE SEATTLE TIMES

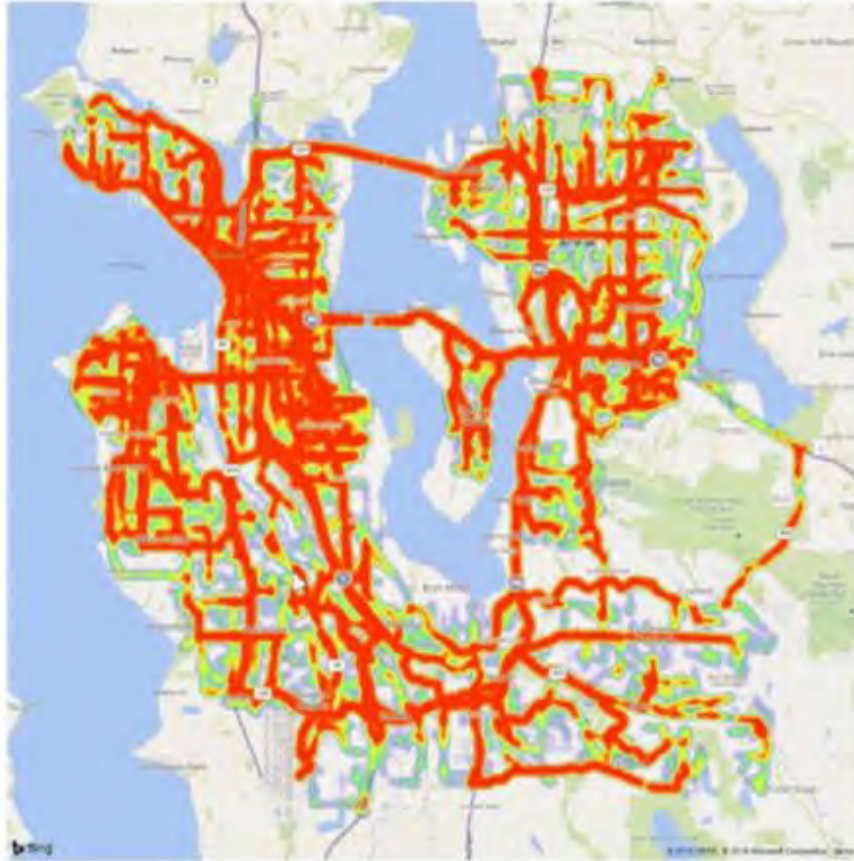


# Adaptive Cruise Control for Traffic Jam Reduction

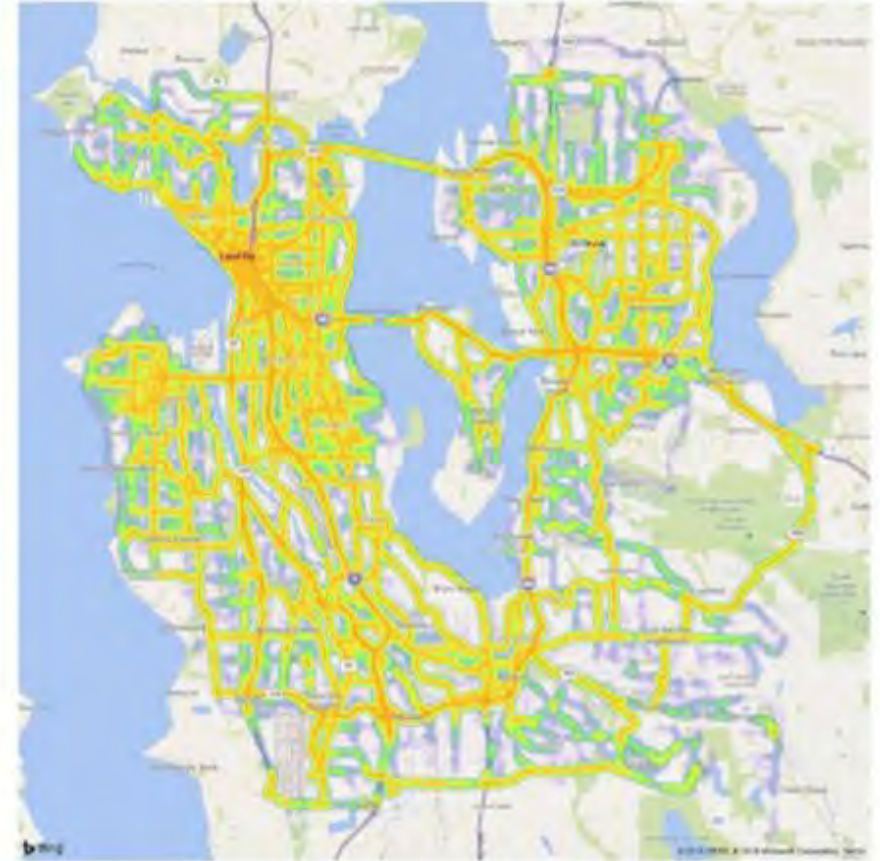




Ford & Microsoft simulate powerful computing solving congestion cooperatively for 5,000 cars simultaneously



Before



After

Overall congestion level reduced by 73% | Average commute time reduced by 8%



# UNSUSTAINABLE?

The Growth of App-Based Ride Services and  
Traffic, Travel and the Future of New York City

FEBRUARY 27, 2017

**SCHALLER  
CONSULTING**

94 Windsor Place, Brooklyn NY 11215  
718 768 3487  
bruceschaller2@gmail.com



## TNCs & Congestion

DRAFT REPORT | OCTOBER 2018



# Will AVs reduce congestion?

## YES SIDE...

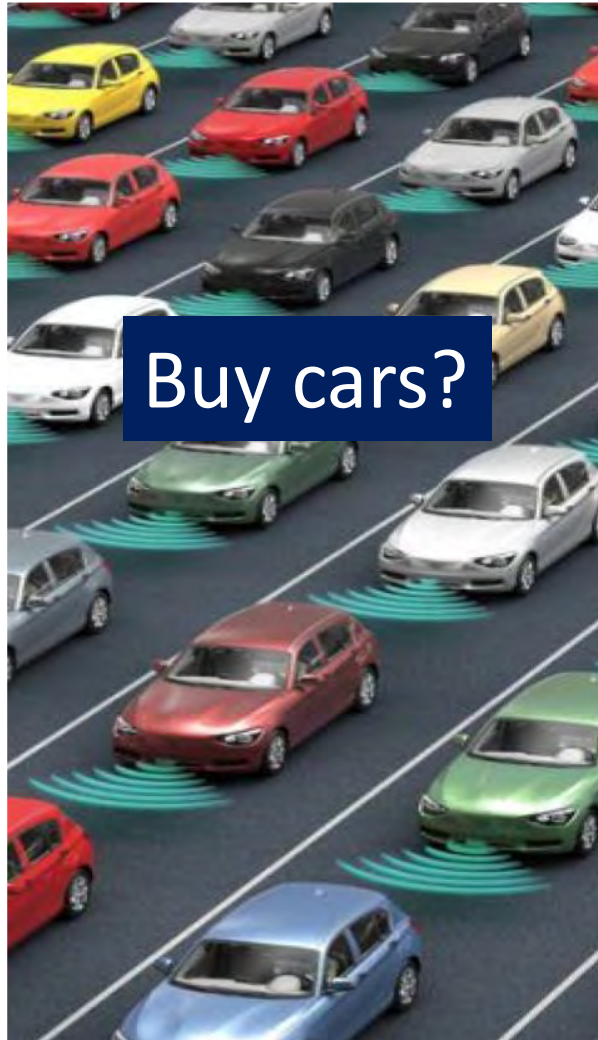
- Driver assistance automation & collision avoidance → **reduce accidents.**
- Automated speed control & braking → **smoother flows.**
- Precision guidance → **fit more cars** into existing road space.
- Automated parking → cars quickly **out of the way.**
- More use of shared-ride services → **fewer private cars** on the street

## NO SIDE...

- Automated features → **more/longer trips.**
- Travel time **more productive** → **more trips.**
- Older, younger, unlicensed and disabled drivers → **more trips.**
- Volume of cars and driving → may **exceed efficiency gains.**
- Easier, safer driving → **more driving** will be the result



What is our  
buy-ride /  
share-ride  
ratio target?



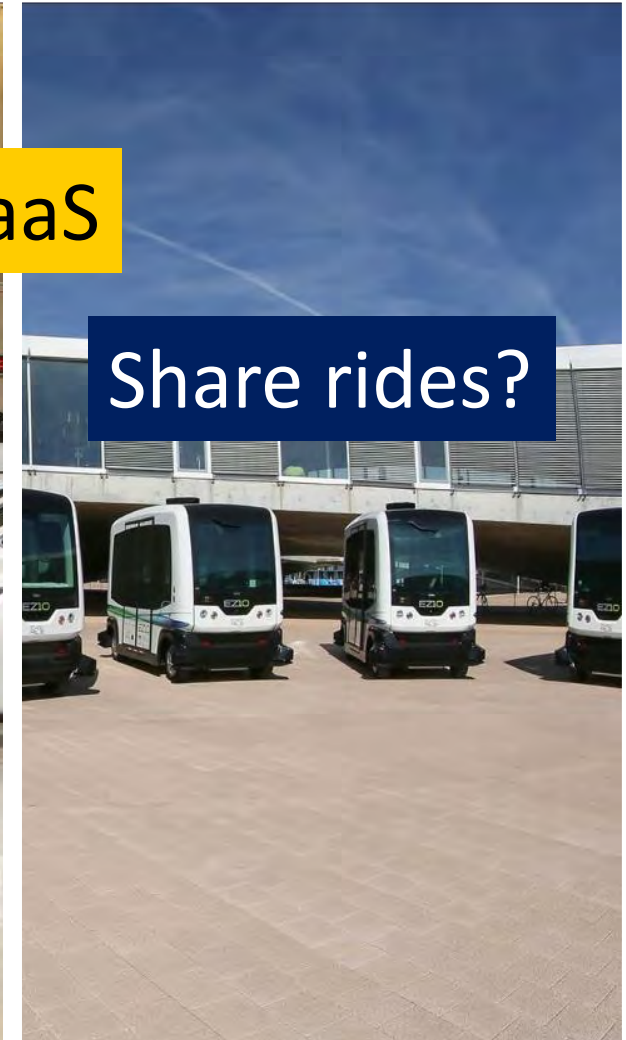
Buy cars?

Market 1



Buy rides?

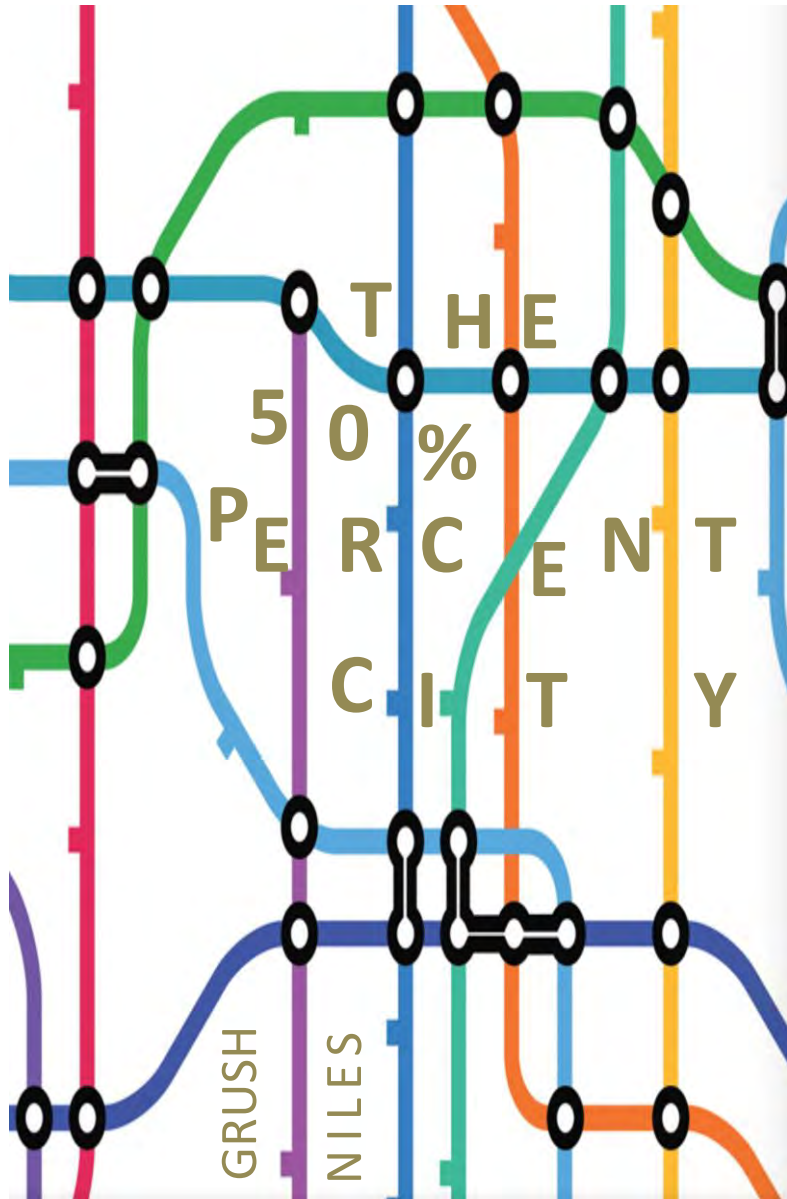
MaaS



Share rides?

Market 2

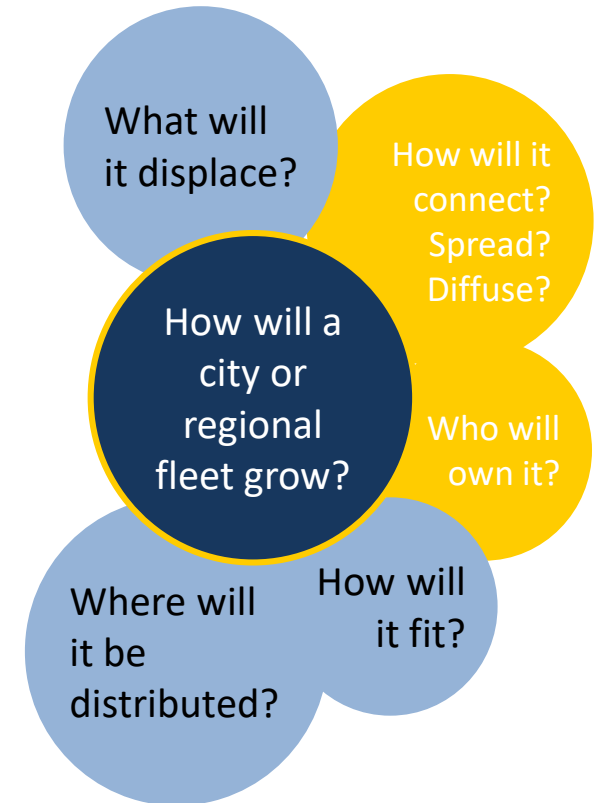
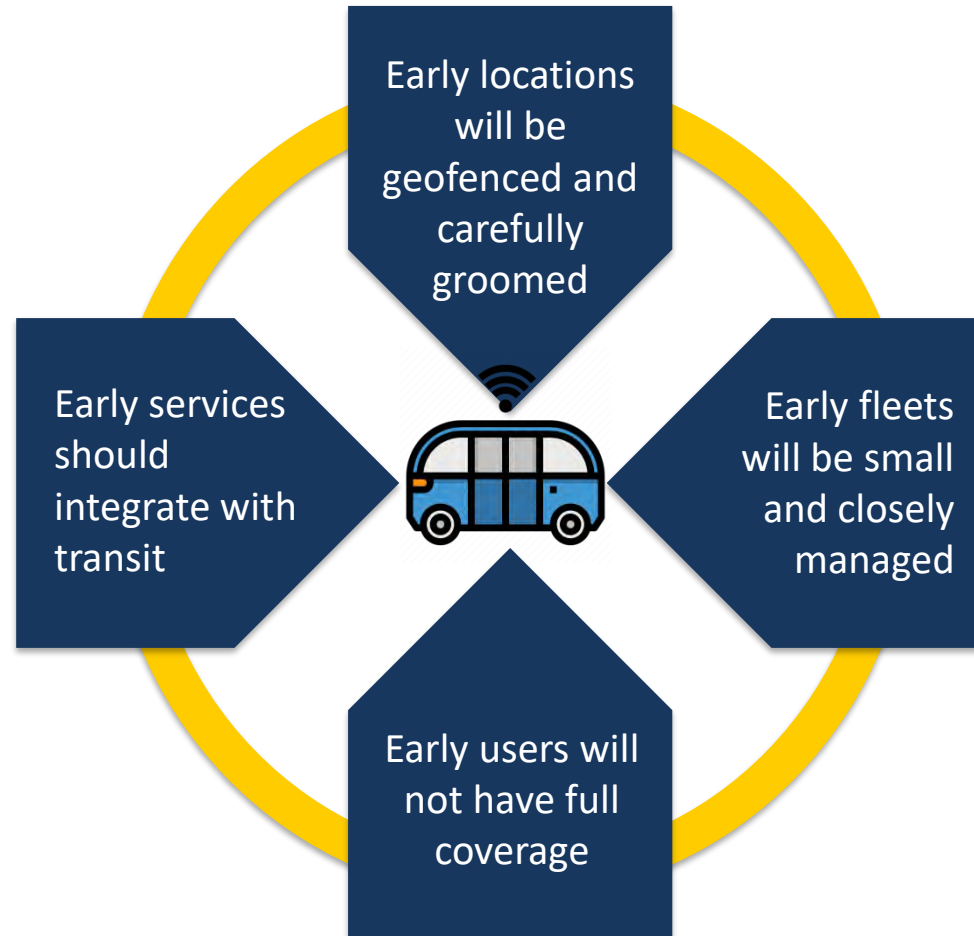




# Next Grush-Niles book

*What will it take to prepare your city for fifty percent of its passenger travel (and goods movement!) provided in shared, driverless, motor vehicles?*







# Menu of steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **Public and government adopt these attitudes**
  - Understand mode split realities and small vehicle geographic reach
  - Larger vision of “public transit” to include small vehicle services
  - Support intermodalism: private, small vehicles  $\leftarrow \rightarrow$  heavy public transit
  - Support Universal Basic Mobility in small vehicle modes
  - Not all streets need to be “complete”
  - Insist that deployed Market 2 AVs be ultra safe
- **Maintain private sector and government work in progress**
  - Grow vehicle efficiency – electric powered cars
  - Embrace automated driver assistance systems
  - Deploy first/last mile microtransit with drivers for proof of business case and growth potential
  - Fund and maintain roads via 18<sup>th</sup> amendment and RUC
  - Manage curbs and sidewalks
  - Explore potential for congestion-clearing payments to commuters
  - Manage taxis and TNCs with trip-by-trip fees and subsidies

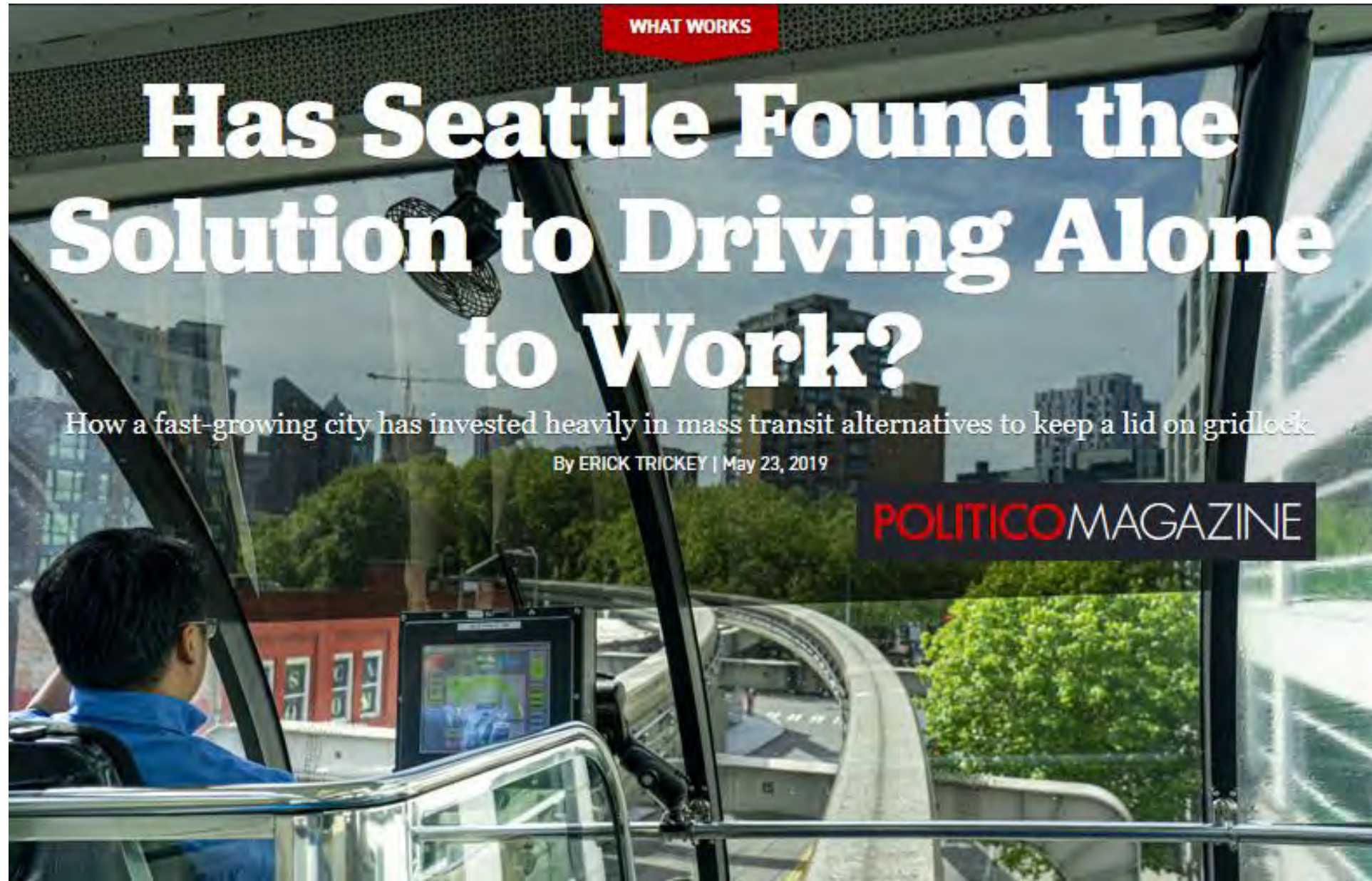


# Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **Public and government adopt these attitudes**
  - **Understand mode split realities and small vehicle geographic reach**
  - Larger vision of “public transit” to include small vehicle services
  - Support intermodalism: private, small vehicles  $\leftrightarrow$  heavy public transit
  - Support Universal Basic Mobility in small vehicle modes
  - Not all streets need to be “complete”
  - Insist that deployed Market 2 AVs be ultra safe
- **Maintain private sector and government work in progress**
  - Grow vehicle efficiency – electric powered cars
  - Embrace automated driver assistance systems
  - Deploy first/last mile microtransit with drivers for proof of business case and growth potential
  - Fund and maintain roads via 18<sup>th</sup> amendment and RUC
  - Manage curbs and sidewalks
  - Explore potential for congestion-clearing payments to commuters
  - Manage taxis and TNCs with trip-by-trip fees and subsidies



## Mode split realities?



WHAT WORKS

# Has Seattle Found the Solution to Driving Alone to Work?

How a fast-growing city has invested heavily in mass transit alternatives to keep a lid on gridlock.

By ERICK TRICKEY | May 23, 2019

**POLITICO**MAGAZINE

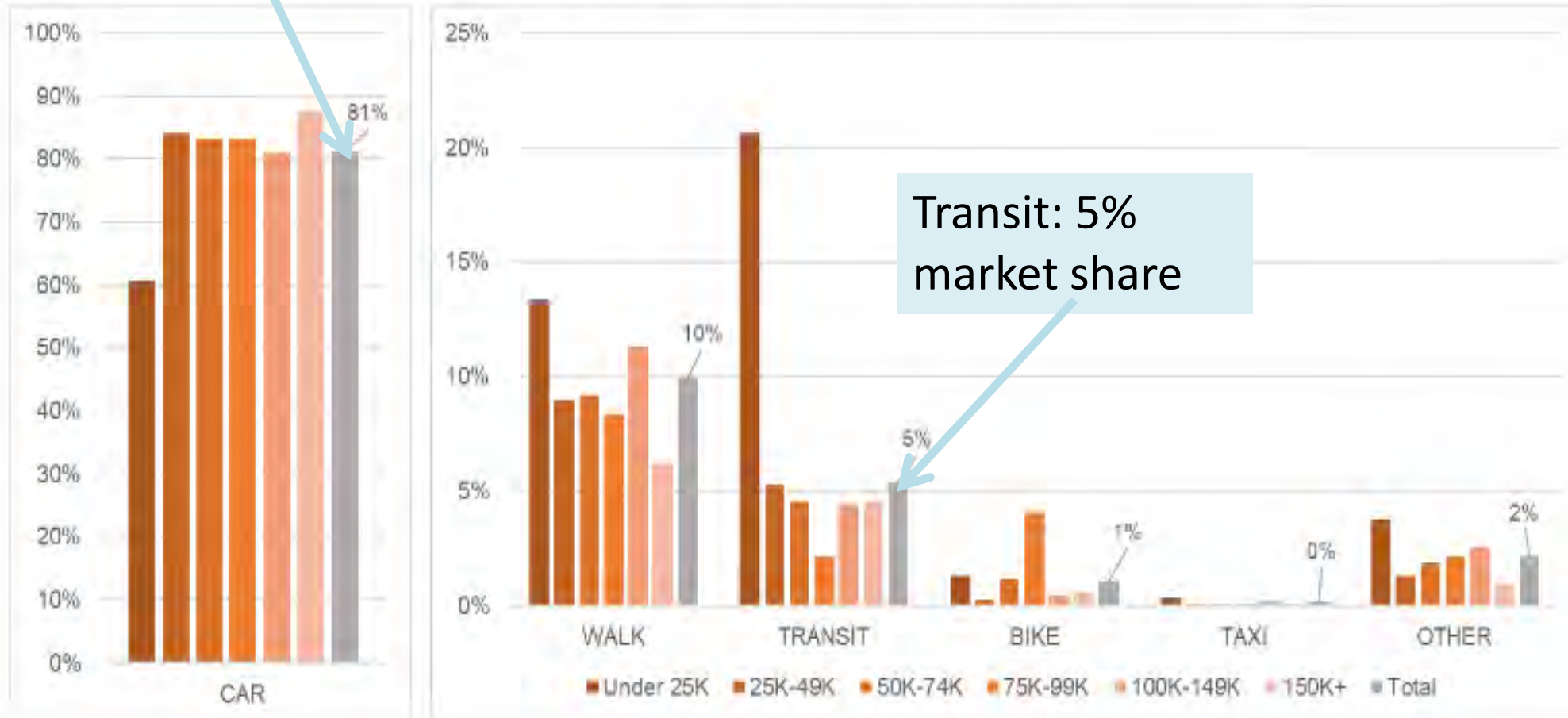


# Mode shares in central Puget Sound region

Cars: 81%  
market share

Puget Sound Regional Council  
2017 Puget Sound Regional Travel Study

FIGURE 20: TRIP MODE BY HOUSEHOLD INCOME (WEIGHTED)



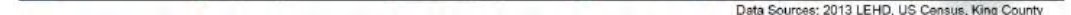


# Issue Overview

- On a trip volume basis, private driving is massive; public transit is trivial.
- Planners' concern: Market 1 ADAS is going to lead to massive consumption of personal mobility, ie, more SOV driving.
- Car-less, transit-mostly, walkable dense development is public policy in the central Puget Sound region, named "Growing Transit Communities"
- Focusing vehicle automation on Cooperative Automated Transportation is WSDOT policy
- Grush Niles focus on Market 2 shared rides is complementary to state and local public policy.

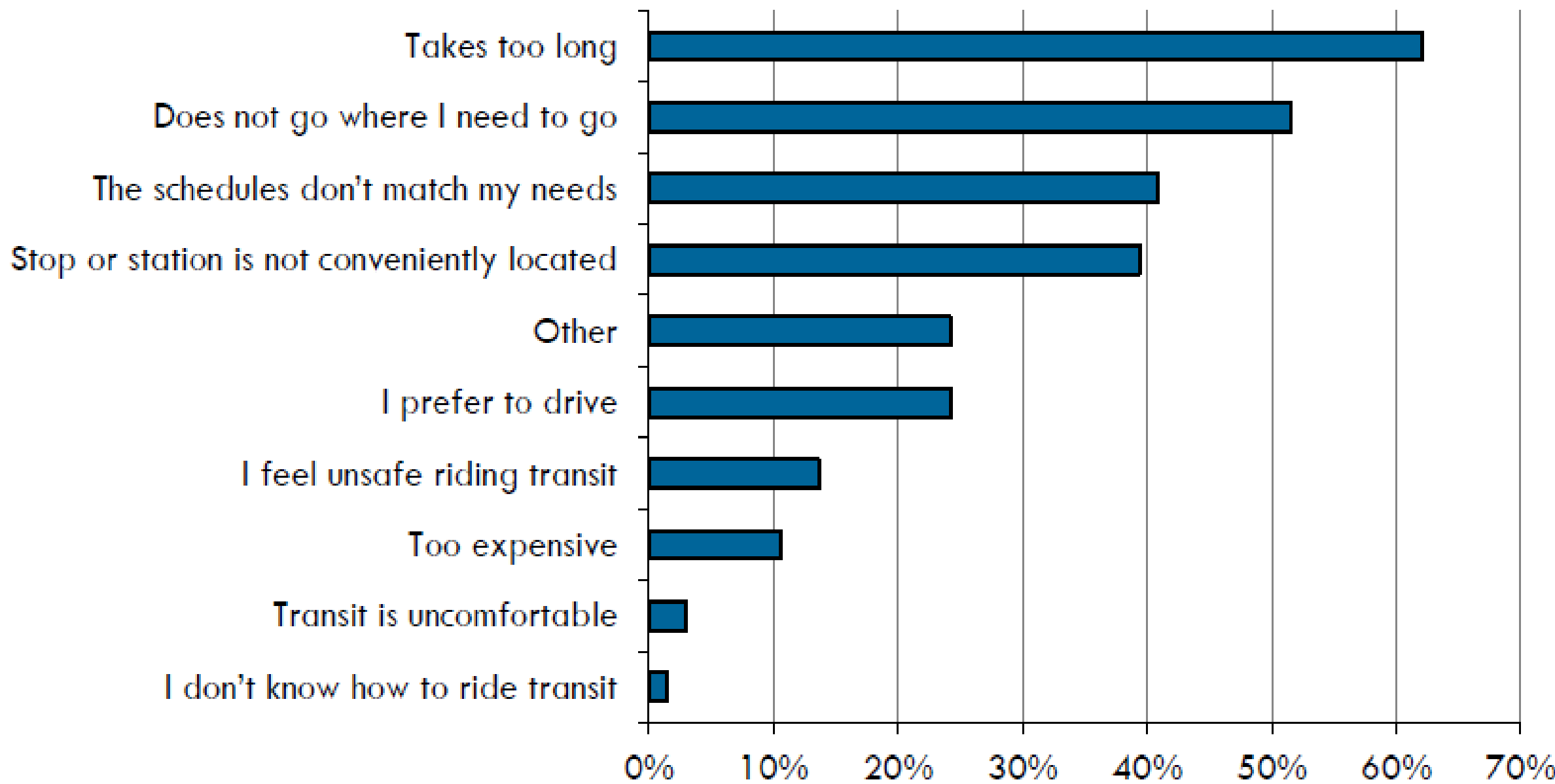


And the reach of public transit for these dispersed workers is limited.





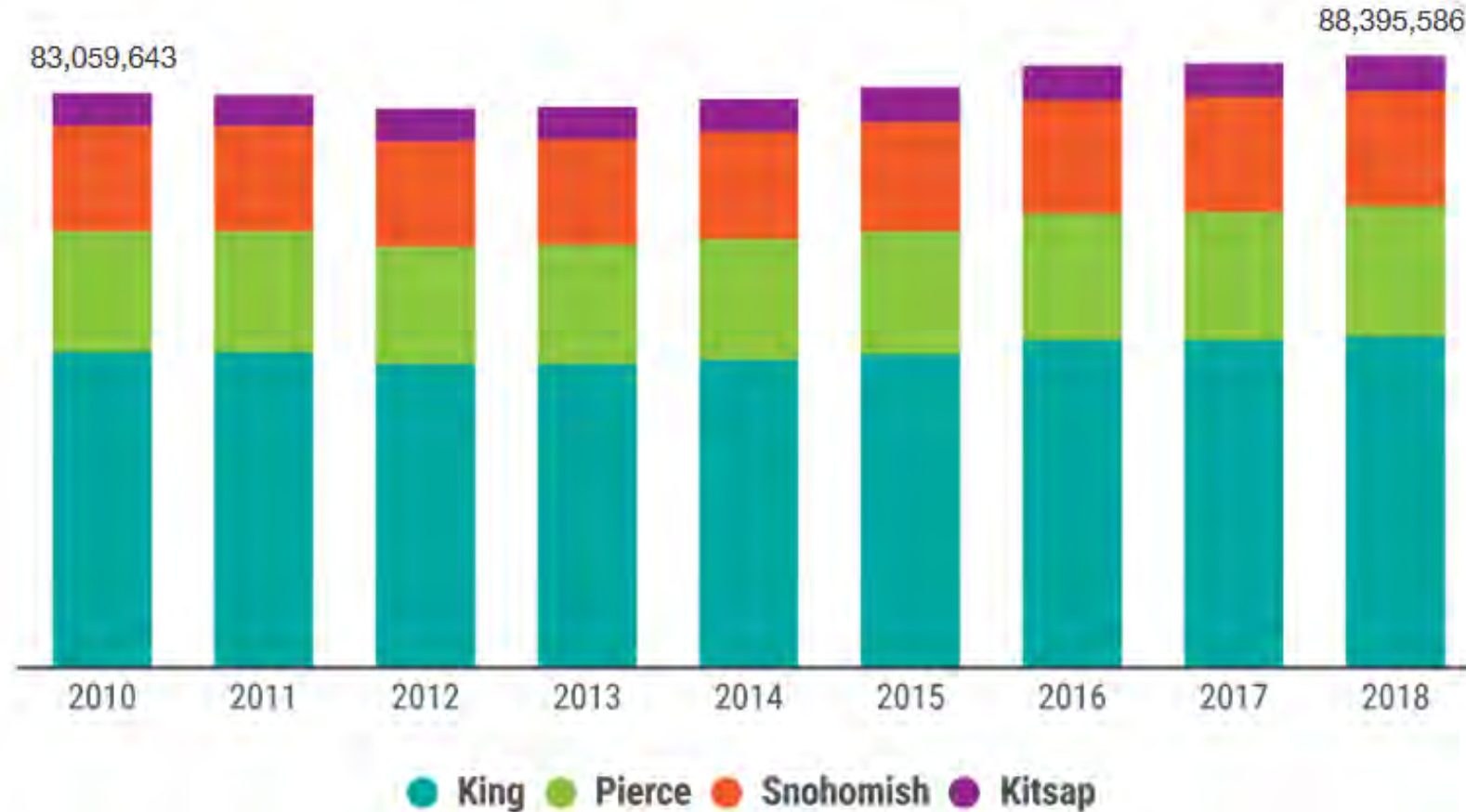
**Figure 78**      **Reasons why Respondents May Choose to Not Ride Transit (Multiple Responses Possible)**





# Prominence of personal automobility

Daily Vehicle Miles Traveled





# Transit Trips vs Car Trips

## Central Puget Sound Region

- *King County Metro:* **122.5 million riders per year**
- *Sound Transit:* **48.2 million riders in 2018**
- *Total, ALL regional transit:* **221 million riders in 2018**
  
- *Passenger trips in cars every weekday:* **12.5 million**
  
- *Passenger cars provide more trips every 18 weekdays than the Puget Sound region's transit agencies provide in an entire year*



Plans for the  
future do  
not change  
the cars-to-  
transit ratio  
much!



## Regional Transportation Plan

### Final Environmental Impact Statement 2018 Addendum

April 2018

Puget Sound Regional Council

**Exhibit 5**  
**Travel Mode Shares**

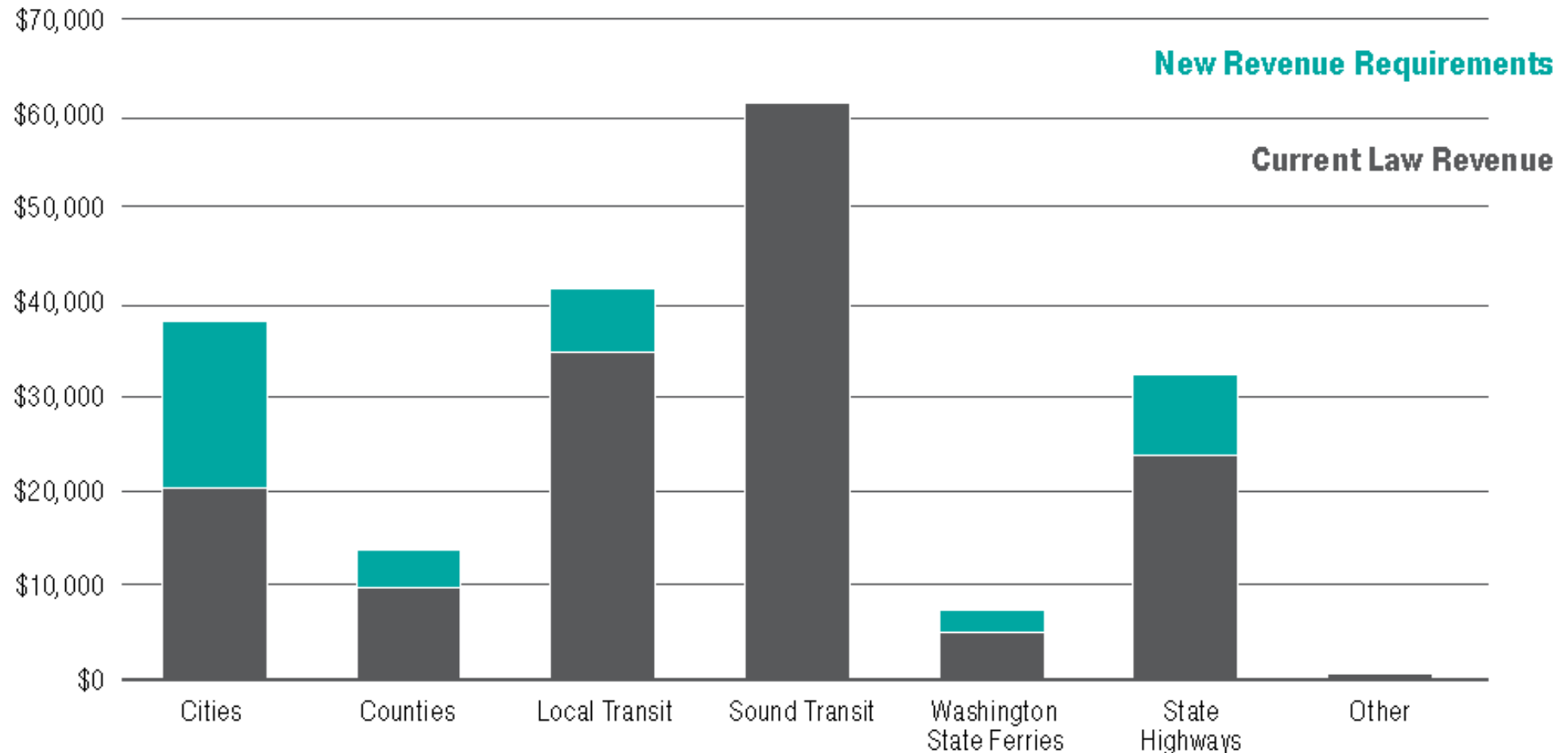
Mode	Base Year (2014)	2018 Regional Transportation Plan	
		2040 Constrained Plan	2040 Full Plan
Drive Alone	40%	38%	38%
Shared Ride	39%	36%	36%
Transit	3%	5%	5%
Nonmotorized	17%	21%	21%

Note: Numbers do not add to 100 due to rounding.



# Cost of public transit creates need for efficiency in public transit expansion

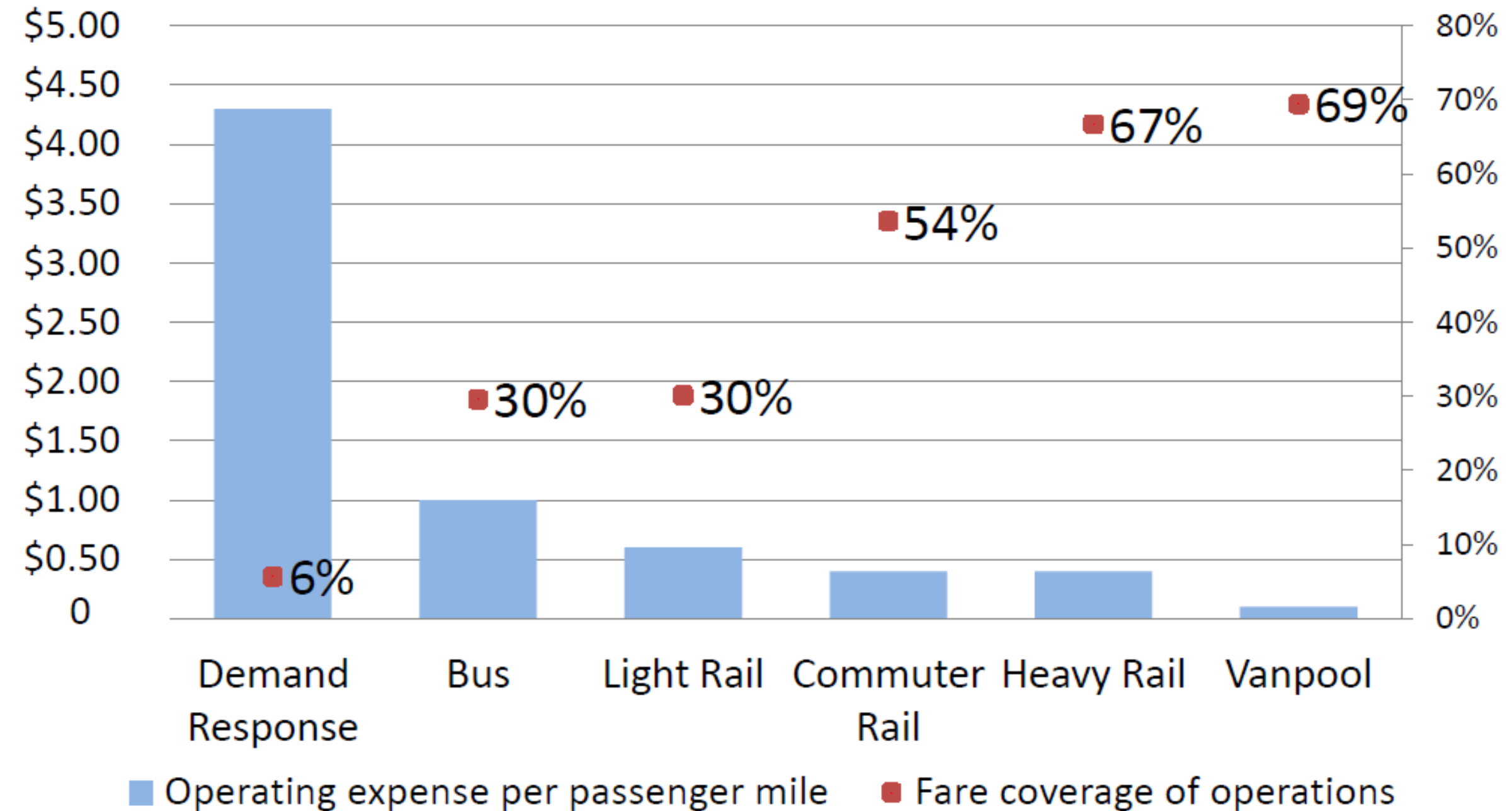
Figure 17. New Revenue Requirements (millions of year \$2018 constant dollars)



Source: Puget Sound Regional Council Regional Transportation Plan, May 2018,  
<https://www.psrc.org/our-work/rtp>



# Effect of Driver Wages on Cost per Passenger Mile by Mode



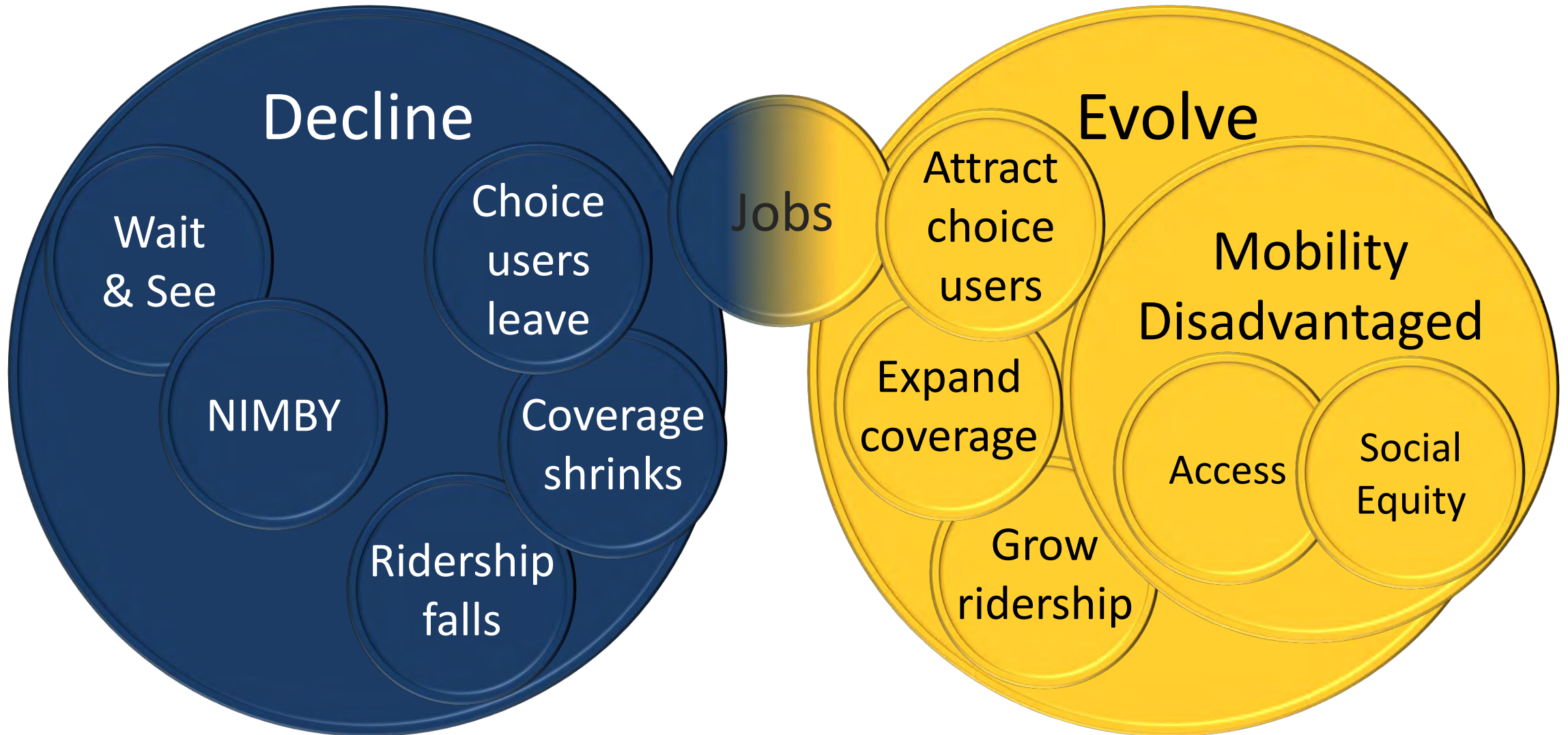


# Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **Public and government adopt these attitudes**
  - Understand mode split realities and small vehicle geographic reach
  - **Larger vision of “public transit” to include small vehicle services**
  - Support intermodalism: private, small vehicles  $\leftrightarrow$  heavy public transit
  - Support Universal Basic Mobility in small vehicle modes
  - Not all streets need to be “complete”
  - Insist that deployed Market 2 AVs be ultra safe
- **Maintain private sector and government work in progress**
  - Grow vehicle efficiency – electric powered cars
  - Embrace automated driver assistance systems
  - Deploy first/last mile microtransit with drivers for proof of business case and growth potential
  - Fund and maintain roads via 18<sup>th</sup> amendment and RUC
  - Manage curbs and sidewalks
  - Explore potential for congestion-clearing payments to commuters
  - Manage taxis and TNCs with trip-by-trip fees and subsidies



# What happens to public transportation systems?





M

t of





# Great perspective from Steve Polzin

The goal is not to preserve the institutions or technologies that we know as public transportation today.

The goal is to ensure that the public purposes public transportation serves continue to be met in the future.



# Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

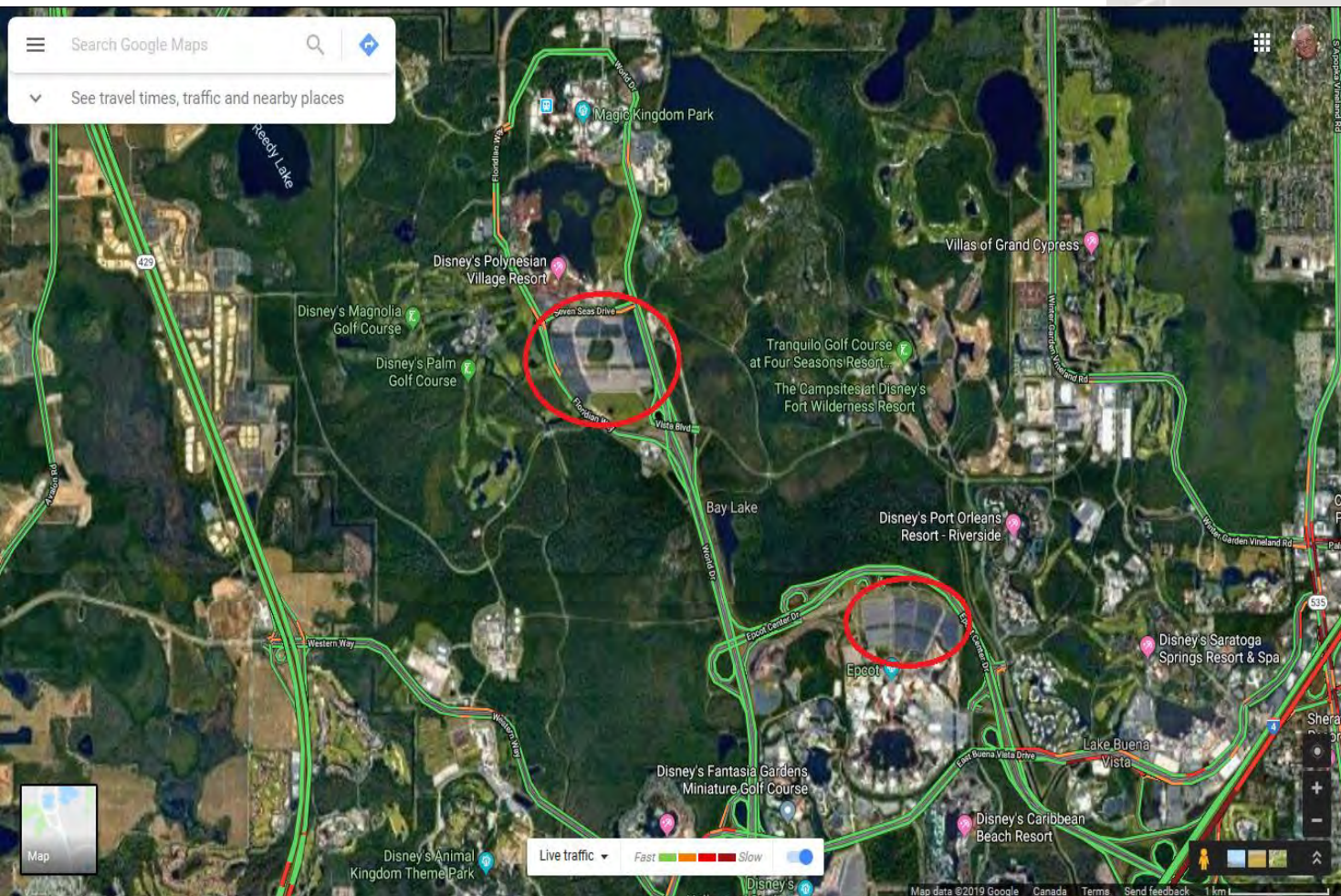
- **Public and government adopt these attitudes**
  - Understand mode split realities and small vehicle geographic reach
  - Larger vision of “public transit” to include small vehicle services
  - **Support intermodalism: private, small vehicles  $\leftrightarrow$  heavy public transit**
  - Support Universal Basic Mobility in small vehicle modes
  - Not all streets need to be “complete”
  - Insist that deployed Market 2 AVs be ultra safe
- **Maintain private sector and government work in progress**
  - Grow vehicle efficiency – electric powered cars
  - Embrace automated driver assistance systems
  - Deploy first/last mile microtransit with drivers for proof of business case and growth potential
  - Fund and maintain roads via 18<sup>th</sup> amendment and RUC
  - Manage curbs and sidewalks
  - Explore potential for congestion-clearing payments to commuters
  - Manage taxis and TNCs with trip-by-trip fees and subsidies



# Park & Ride Space at Full Capacity Everywhere

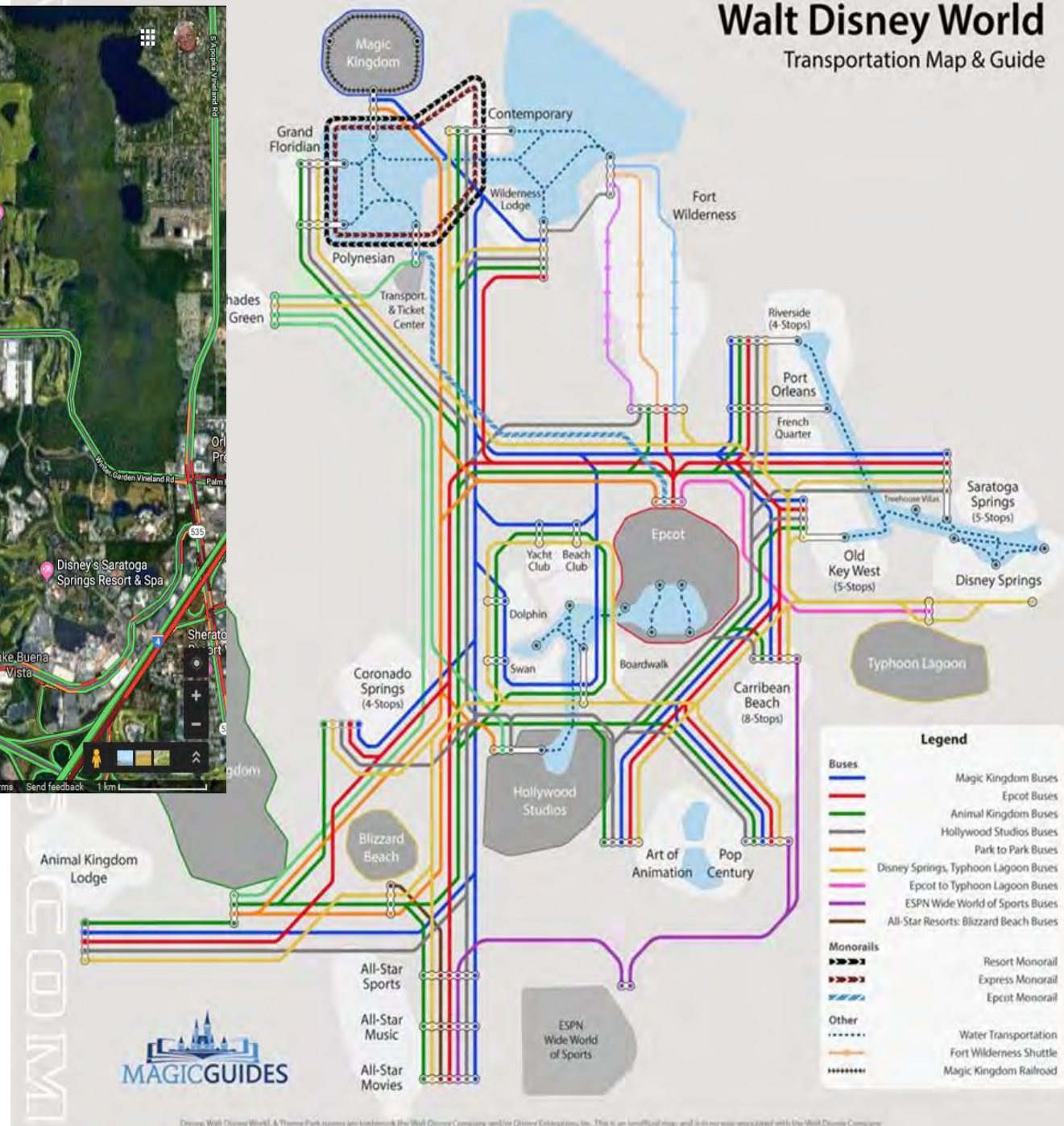
Park & Ride Name	City	Subarea	Capacity	% Utilization	Owner
Tacoma Dome Station	Tacoma	Pierce County	2337	94	Pierce Transit
Eastgate P&R	Bellevue	East King County	1614	97	WSDOT
Lynnwood Transit Center	Lynnwood	Snohomish County	1358	99	WSDOT
Federal Way Transit Center	Federal Way	South King County	1190	99	King County Metro Transit
Angle Lake Station	SeaTac	South King County	1160	99	King County Metro Transit
Ash Way	Lynnwood	Snohomish County	1039	106	WSDOT
Issaquah Highlands P&R	Issaquah	East King County	1010	97	King County Metro Transit
Everett Station	Everett	Snohomish County	1076	85	Everett Transit
Mountlake Terrace Transit Center	Mountlake Terrace	Snohomish County	878	99	WSDOT
Kent Garage at Kent Station	Kent	South King County	877	95	Sound Transit
South Kirkland P&R	Kirkland	East King County	833	98	King County Metro Transit
Issaquah Transit Center	Issaquah	East King County	819	97	Sound Transit
Kenmore P&R	Kenmore	North King County	606	96	King County Metro Transit
Tukwila International Blvd Station	Tukwila	South King County	600	96	Sound Transit
Auburn Garage at Auburn Station	Auburn	South King County	520	99	Sound Transit
Lakewood Station	Lakewood	Pierce County	541	93	Pierce Transit
Kingsgate P&R	Kirkland	East King County	502	99	WSDOT
Northgate TC Extension	Seattle	North King County	448	100	King County Metro Transit
Mercer Island P&R	Mercer Island	East King County	447	98	WSDOT





Disney World inside is all transit and walkability

Around the edges connected to freeways and tollways is massive paid parking







# Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **Public and government adopt these attitudes**
  - Understand mode split realities and small vehicle geographic reach
  - Larger vision of “public transit” to include small vehicle services
  - Support intermodalism: private, small vehicles  $\leftrightarrow$  heavy public transit
  - **Support Universal Basic Mobility in small vehicle modes**
  - Not all streets need to be “complete”
  - Insist that deployed Market 2 AVs be ultra safe
- **Maintain private sector and government work in progress**
  - Grow vehicle efficiency – electric powered cars
  - Embrace automated driver assistance systems
  - Deploy first/last mile microtransit with drivers for proof of business case and growth potential
  - Fund and maintain roads via 18<sup>th</sup> amendment and RUC
  - Manage curbs and sidewalks
  - Explore potential for congestion-clearing payments to commuters
  - Manage taxis and TNCs with trip-by-trip fees and subsidies



# Mobility Disadvantaged

- 
- Cannot use a car
    - Cannot afford one
    - Physically unable to drive
    - Psychologically unable to drive
    - Too old
    - Too young
    - License suspended
  - Do not have a car
    - Too few/zero cars in household
  - Opposed to own/use cars

- 
- Inadequate transit where they live
  - Must use a car (no choice)
  - Inadequate alternatives nearby
  - Do not understand transit
    - Visitors
    - Cognitive challenge



# Universal Basic mobility

A system of public policy concepts and partnerships to provide a minimum level of mobility to all members of society.

Provide the mobility disadvantaged with not only low-fare transit passes and electric scooters, but what car owners have:

Short-notice, anywhere, anytime, reasonably fast and reliable, point-to-point motorized travel, when needed.

TRANSIT REDEFINED delivers UNIVERSAL BASIC MOBILITY



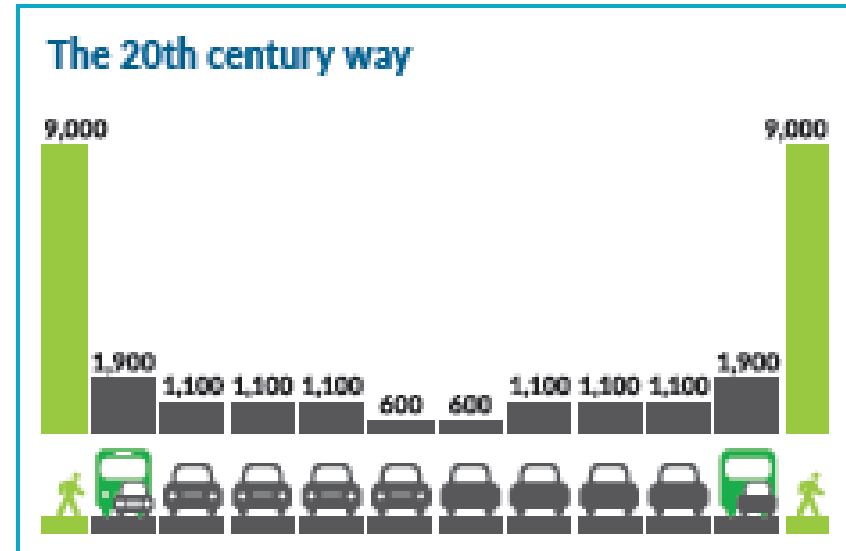
# Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **Public and government adopt these attitudes**
  - Understand mode split realities and small vehicle geographic reach
  - Larger vision of “public transit” to include small vehicle services
  - Support intermodalism: private, small vehicles  $\leftrightarrow$  heavy public transit
  - Support Universal Basic Mobility in small vehicle modes
  - **Not all streets need to be “complete”**
  - Insist that deployed Market 2 AVs be ultra safe
- **Maintain private sector and government work in progress**
  - Grow vehicle efficiency – electric powered cars
  - Embrace automated driver assistance systems
  - Deploy first/last mile microtransit with drivers for proof of business case and growth potential
  - Fund and maintain roads via 18<sup>th</sup> amendment and RUC
  - Manage curbs and sidewalks
  - Explore potential for congestion-clearing payments to commuters
  - Manage taxis and TNCs with trip-by-trip fees and subsidies

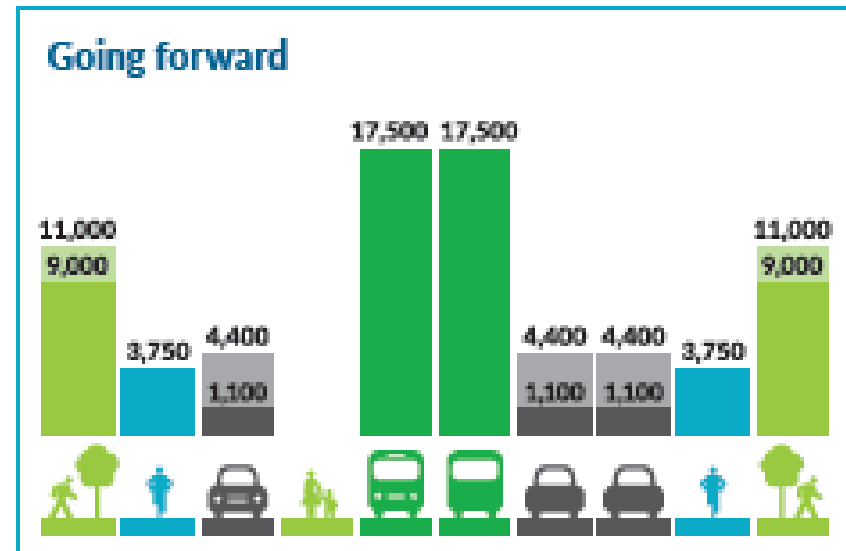


From WSDOT

## Two contrasting street configurations



This street can serve up to **29,600** people per hour.



This street can serve up to **77,000** people per hour.



# Not all streets need to be multiple modal – specialization is OK

- Pedestrian streets
- Transit streets
- Bike streets
- Truck streets
- Automated electric shuttle streets
- Streets for residents' personal vehicles only



# Decide what to make room for?



**This seems an unusually specialized street**

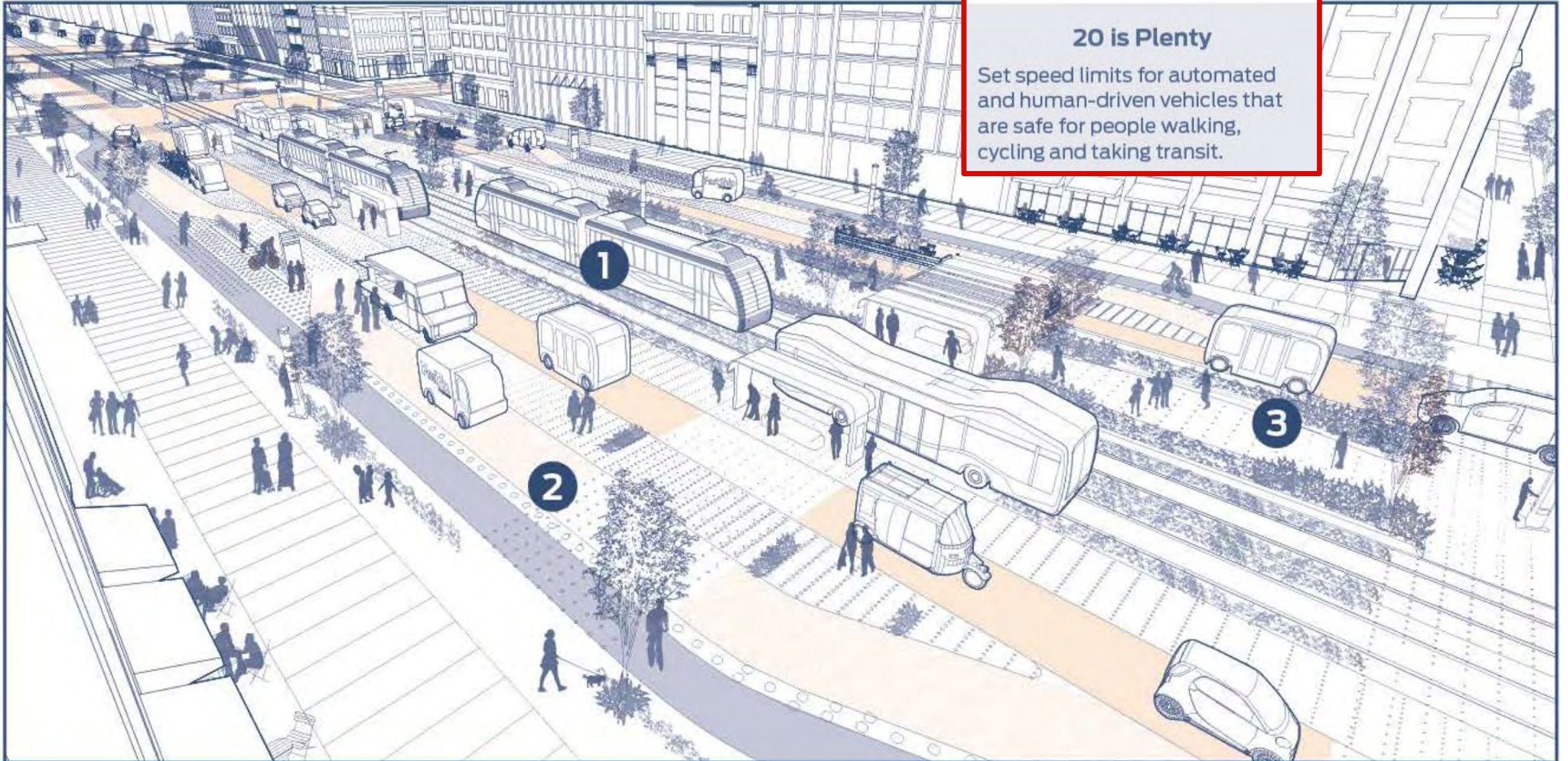
- ☒ Bus
- ☒ Pedestrian
- ☒ Car
- ☐ Robotaxi
- ☐ Bike
- ☐ Scooter
- ☐ Street crossing
- ☐ Goods Delivery



*Safety is the Top Priority*

### 20 is Plenty

Set speed limits for automated and human-driven vehicles that are safe for people walking, cycling and taking transit.



NACTO: Blueprint for Autonomous Urbanism



Bikes are apparently OK on this temporarily car-free boulevard in Paris.

How about electric bikes?

How about electric skate boards?

How about golf-cart sized EVs?

Right-of-way regulation is a local government responsibility – flexible response to citizen interests is good.



A man runs as his daughters bicycle on the Avenue des Champs-Élysées during a day without cars in Paris, Sunday, Sept. 22, 2019. / The New York Times/AP

#### PERSPECTIVE

## Why Car-Free Streets Will Soon Be the Norm

In cities like New York, Paris, Rotterdam, and soon San Francisco, car-free streets are emerging amid a growing movement.

DECEMBER 10, 2019



**BROOKS RAINWATER**

Brooks Rainwater is a Senior Executive at National League of Cities.

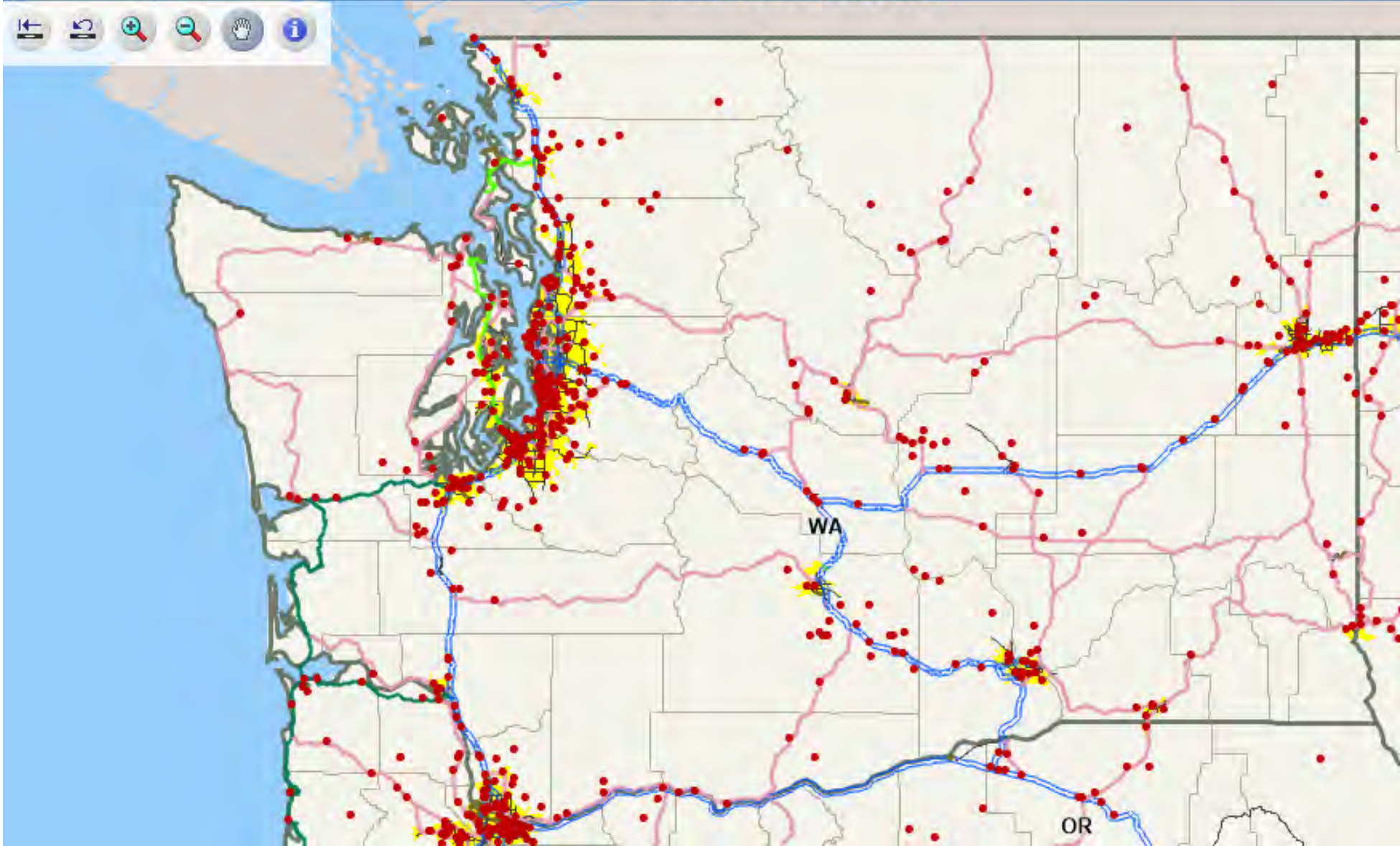


# Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **Public and government adopt these attitudes**
  - Understand mode split realities and small vehicle geographic reach
  - Larger vision of “public transit” to include small vehicle services
  - Support intermodalism: private, small vehicles  $\leftrightarrow$  heavy public transit
  - Support Universal Basic Mobility in small vehicle modes
  - Not all streets need to be “complete”
  - **Insist that deployed Market 2 AVs be ultra safe**
- **Maintain private sector and government work in progress**
  - Grow vehicle efficiency – electric powered cars
  - Embrace automated driver assistance systems
  - Deploy first/last mile microtransit with drivers for proof of business case and growth potential
  - Fund and maintain roads via 18<sup>th</sup> amendment and RUC
  - Manage curbs and sidewalks
  - Explore potential for congestion-clearing payments to commuters
  - Manage taxis and TNCs with trip-by-trip fees and subsidies



Annual Fatal Crashes 2018



Each  
Washington  
State Traffic  
Fatality in  
2018  
indicated by  
a Red Dot.



***Human driving is statistically safe but high traffic volumes make low probability events more likely.***



**Washington State  
Motor Vehicle Travel:**

**170,868,000  
Vehicle Miles Traveled  
Daily in 2018**

**62,367,000,000  
Vehicle Miles Traveled  
in 2018**

**One crash every  
537,000 miles**

**One fatality every  
126 million miles**



# ***Issue with AV testing***

- Economic development via government support of vehicle testing is considered important.
- Safety of the public on public roadways is arguably much more important.
- Much remains to be learned about safety of robotic, automated driving, in contrast with automated assistance to human drivers.
- Grush Niles Strategic suggests State of Washington communities focus on deployment of vehicles and service that are proven safe elsewhere, rather than emphasizing technology testing on public roads.



TEMPE POLICE DEPT.



**FOX 10**

8:05 84°

## DEADLY UBER SELF-DRIVING CAR CRASH

TEMPE POLICE RELEASE BODY CAM, PICTURES & REPORT



## ***CATES recommendation for certification of collision prevention capability of vehicle automation***

- Government authorities should prohibit operation on public roads of automated motor vehicles that have not been certified for object and event detection and appropriate response by a competent process of inspection and verification, as carried out by trained professionals with necessary skills and legal authority. This recommendation is meant as a reasonable step to protect human life in Washington State from a patently avoidable tragedy like experienced with Uber's Volvo in Arizona.



## **Challenge for Public Policy:**

**Is there any justification for driverless robotic cars moving on regulated public roads to be owned and operated by individuals, as opposed to competent, regulated, certified organizations?**

## **Point of Comparison:**

**Privately owned flying drones**

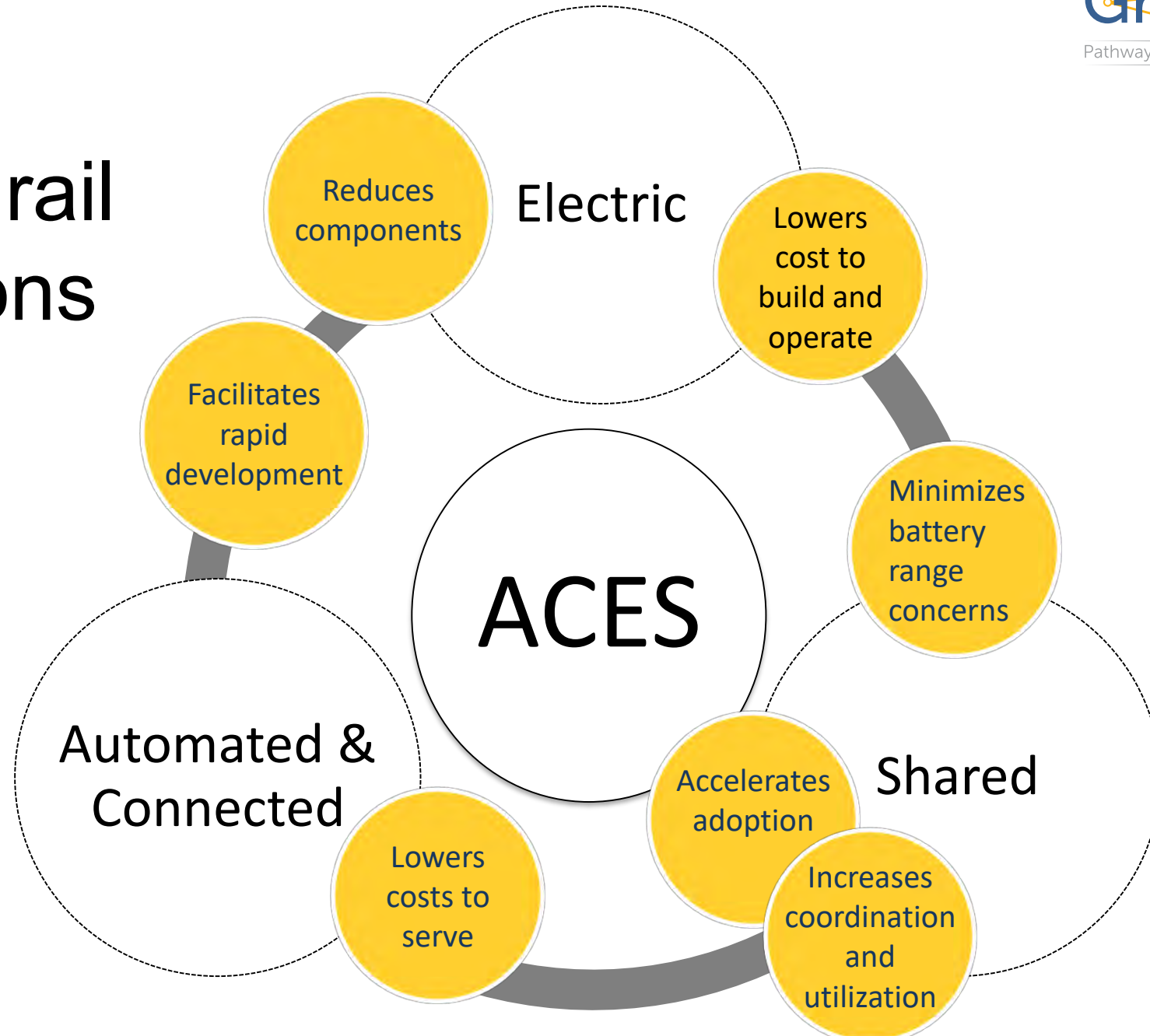


# Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **Public and government adopt these attitudes**
  - Understand mode split realities and small vehicle geographic reach
  - Larger vision of “public transit” to include small vehicle services
  - Support intermodalism: private, small vehicles  $\leftrightarrow$  heavy public transit
  - Support Universal Basic Mobility in small vehicle modes
  - Not all streets need to be “complete”
  - Insist that deployed Market 2 AVs be ultra safe
- **Maintain private sector and government work in progress**
  - **Grow vehicle efficiency – electric powered cars**
  - Embrace automated driver assistance systems
  - Deploy first/last mile microtransit with drivers for proof of business case and growth potential
  - Fund and maintain roads via 18<sup>th</sup> amendment and RUC
  - Manage curbs and sidewalks
  - Explore potential for congestion-clearing payments to commuters
  - Manage taxis and TNCs with trip-by-trip fees and subsidies



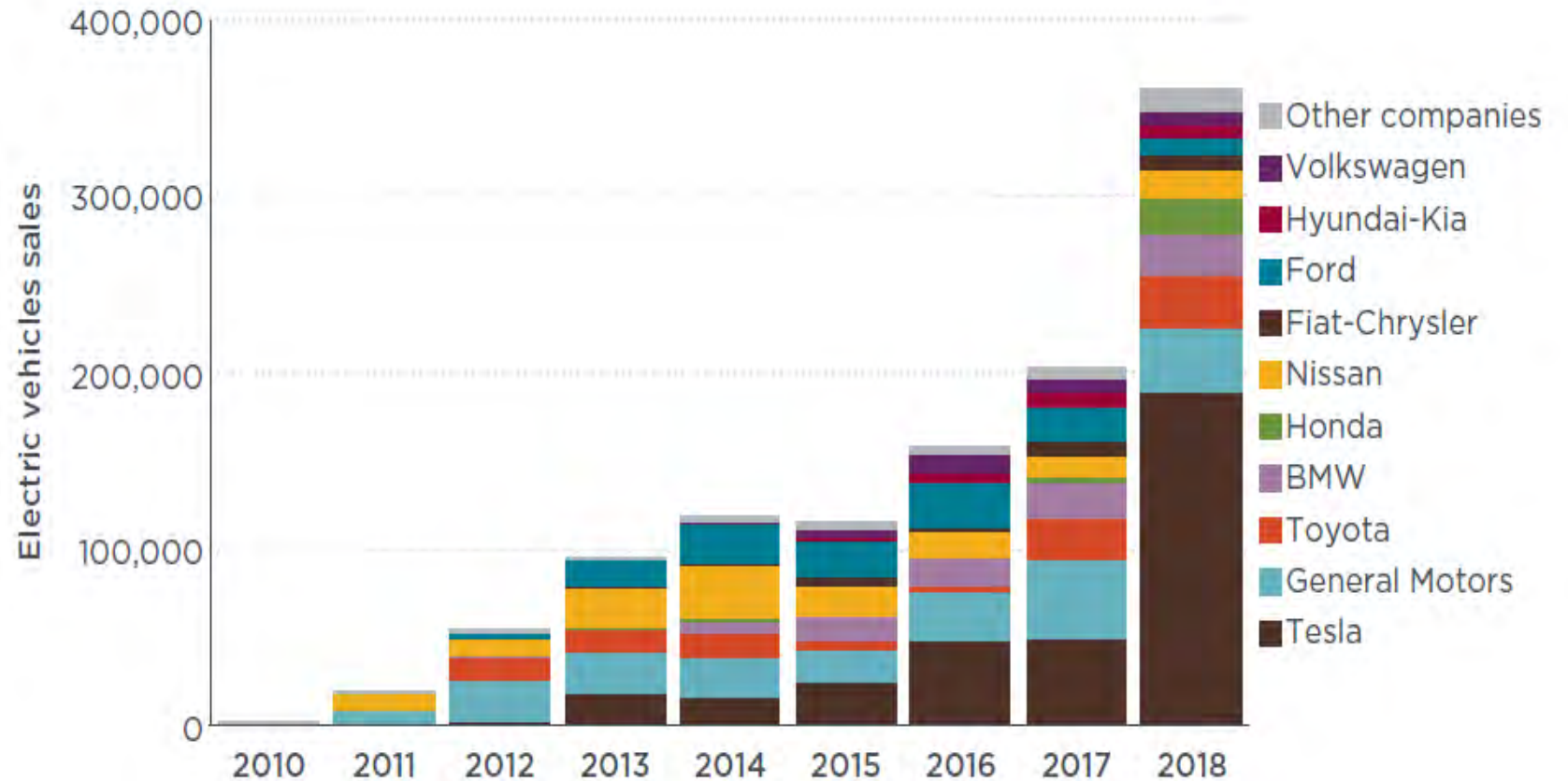
# ACES: The Holy Grail Of Transitions





# Grow vehicle efficiency: electric powered cars

ICCT BRIEFING



**Figure 1.** Automaker electric vehicle sales in the United States through 2018. (Vehicle sales data from EV-volumes, 2019)



[MARKETS](#)[BUSINESS](#)[INVESTING](#)[TECH](#)[POLITICS](#)[CNBC TV](#)

# Detroit's Big Three automakers are looking to a battery-powered future, but each is forging its own path

PUBLISHED SUN, DEC 8 2019 9:30 AM EST

Paul A. Eisenstein

@DETROITBUREAU

SHARE



## KEY POINTS

- Automakers have taken relatively similar approaches to cope with changing market trends in the past, but each manufacturer is following its own strategy for a battery-powered future.
- GM is killing off the Chevy Volt plug-in, while the all-electric Bolt has become the foundation of what CEO Mary Barra on Thursday called “a path to an all-electric future.”
- Ford will cover all its bases, including hybrids, PHEVs and BEVs.
- Fiat Chrysler has lagged its rivals, but that could change. Its merger with France’s PSA could mean an even more aggressive push into battery propulsion.



# Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **Public and government adopt these attitudes**
  - Understand mode split realities and small vehicle geographic reach
  - Larger vision of “public transit” to include small vehicle services
  - Support intermodalism: private, small vehicles  $\leftrightarrow$  heavy public transit
  - Support Universal Basic Mobility in small vehicle modes
  - Not all streets need to be “complete”
  - Insist that deployed Market 2 AVs be ultra safe
- **Maintain private sector and government work in progress**
  - Grow vehicle efficiency – electric powered cars
  - **Embrace automated driver assistance systems**
  - Deploy first/last mile microtransit with drivers for proof of business case and growth potential
  - Fund and maintain roads via 18<sup>th</sup> amendment and RUC
  - Manage curbs and sidewalks
  - Explore potential for congestion-clearing payments to commuters
  - Manage taxis and TNCs with trip-by-trip fees and subsidies



# Automated Low Speed Braking Would Have Kept a Driver From Running Over Me in a Supervised School Crosswalk





# Market 1 Example: Audi



## Audi Q2

Driver assistance systems - overview of sensors

06/16

### Front camera:

- adaptive cruise control (ACC)
- Camera-based traffic Stop&Go incl. Traffic jam assist
- Audi active lane assist
- Camera-based traffic sign recognition
- High beam assist

### Ultrasonic sensors at rear:

- Parking system rear
- Parking system plus
- Parking assist

### Ultrasonic sensors at front:

- adaptive cruise control (ACC)
- Stop&Go incl. Traffic jam assist
- Parking system plus
- Park assistant

### Front radar sensors:

- adaptive cruise control (ACC)
- Stop&Go incl. Traffic jam assist
- Audi active lane assist
- Audi pre-sense front
- Distance display

### Ultrasonic sensors at side:

- Parking assist

### Rear radar sensors:

- adaptive cruise control (ACC)
- Audi active lane assist
- Audi side assist
- Rear cross traffic assist







## Consumer Reports: 57% of members say ADAS prevented a crash

By [John Huetter](#) on June 25, 2019



### Real-world benefits of crash avoidance technologies

IIHS and HLDI study the effects of crash avoidance features by comparing rates of police-reported crashes and insurance claims for vehicles with and without the technologies. (May 2018)

#### Forward collision warning

- ▼ 27% Front-to-rear crashes
- ▼ 20% Front-to-rear crashes with injuries
- ▼ 9% Claim rates for damage to other vehicles
- ▼ 10% Claim rates for injuries to people in other vehicles

#### Forward collision warning plus autobrake

- ▼ 50% Front-to-rear crashes
- ▼ 56% Front-to-rear crashes with injuries
- ▼ 13% Claim rates for damage to other vehicles
- ▼ 23% Claim rates for injuries to people in other vehicles

- ▼ 8% Claim rates for injuries to people in other vehicles

#### Rear automatic braking

- ▼ 62% Backing crashes
- ▼ 12% Claim rates for damage to the insured vehicle
- ▼ 30% Claim rates for damage to other vehicles

#### Rearview cameras

- ▼ 17% Backing crashes





# Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **Public and government adopt these attitudes**
  - Understand mode split realities and small vehicle geographic reach
  - Larger vision of “public transit” to include small vehicle services
  - Support intermodalism: private, small vehicles  $\leftrightarrow$  heavy public transit
  - Support Universal Basic Mobility in small vehicle modes
  - Not all streets need to be “complete”
  - Insist that deployed Market 2 AVs be ultra safe
- **Maintain private sector and government work in progress**
  - Grow vehicle efficiency – electric powered cars
  - Embrace automated driver assistance systems
  - **Deploy first/last mile microtransit with drivers for proof of business case and growth potential**
  - Fund and maintain roads via 18<sup>th</sup> amendment and RUC
  - Manage curbs and sidewalks
  - Explore potential for congestion-clearing payments to commuters
  - Manage taxis and TNCs with trip-by-trip fees and subsidies



# Existing collaborations: Transit +TNCs



Many public agencies  
already collaborate with  
commercial ridehailers  
such as Uber or Lyft

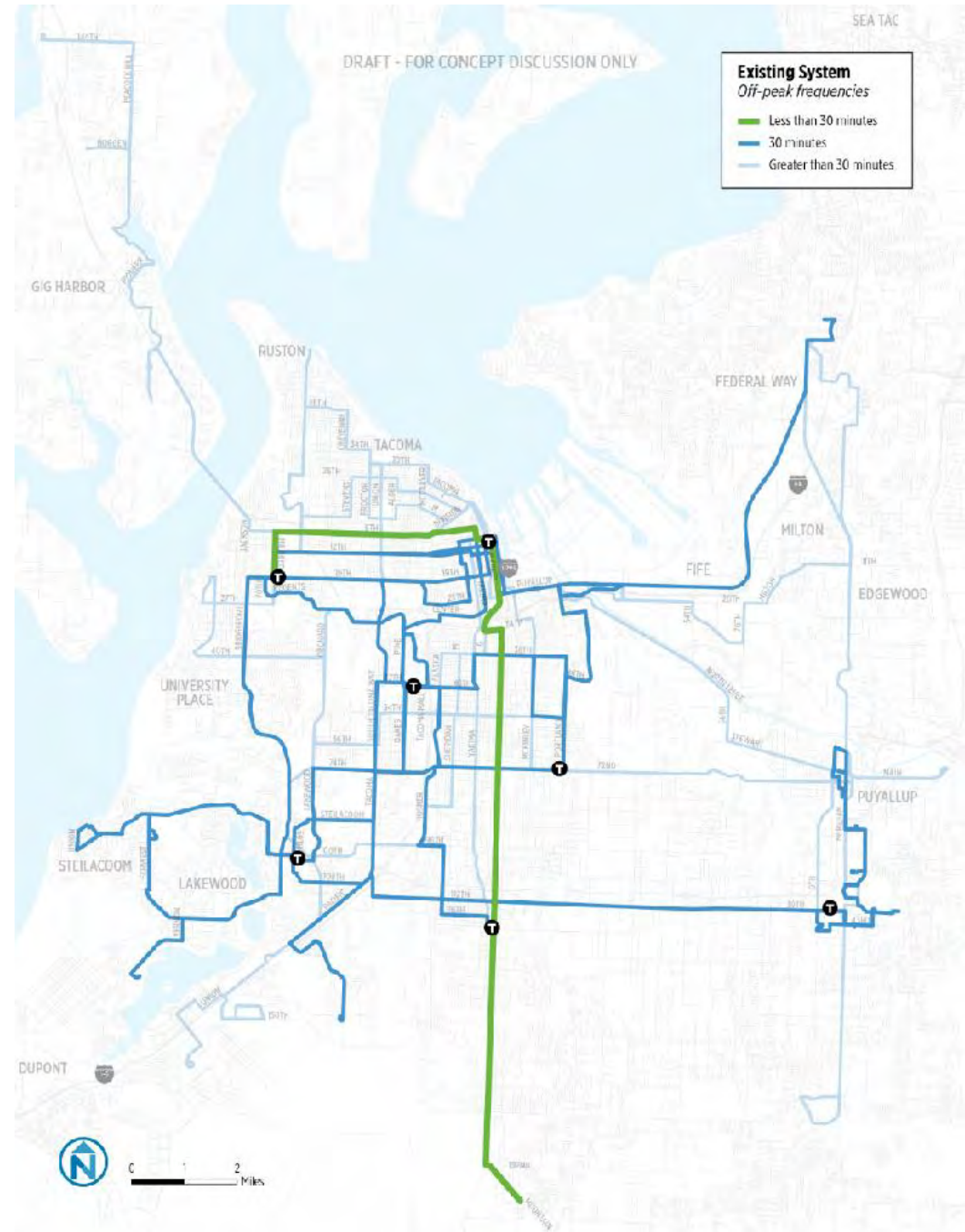
Report by:  
Joseph Schwieterman  
Chaddick Institute, DePaul



Pierce County example  
of transit coverage

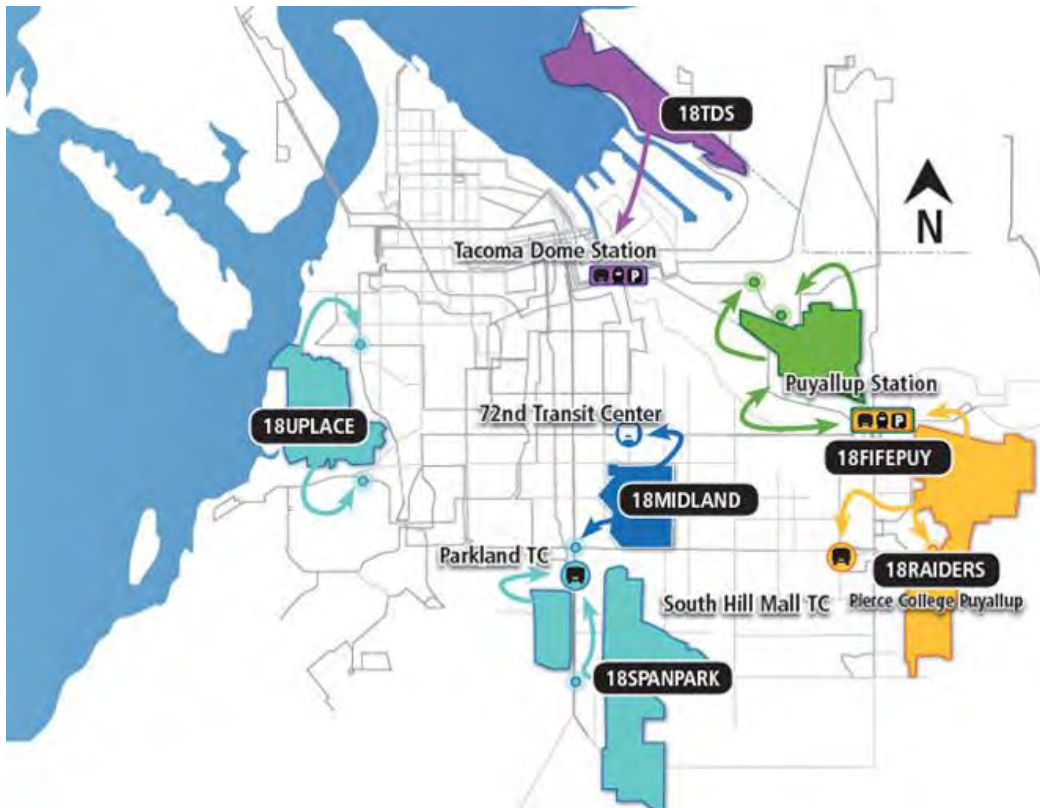
Bus network has limited  
geographic reach

Frequency and time of  
day service also limited





# Example: Pierce Transit and Lyft



## LIMITED ACCESS CONNECTIONS

PILOT PROGRAM ENDS DECEMBER 31, 2019

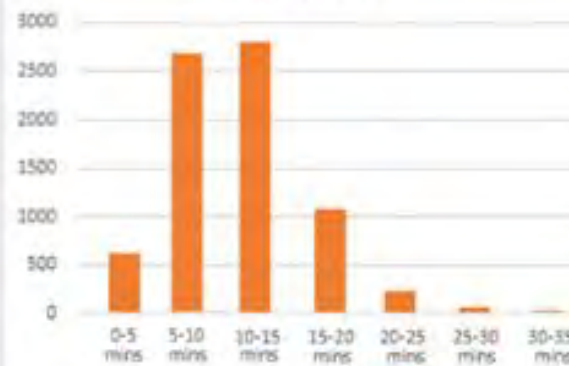


Providing first and last mile service  
connections for transit users

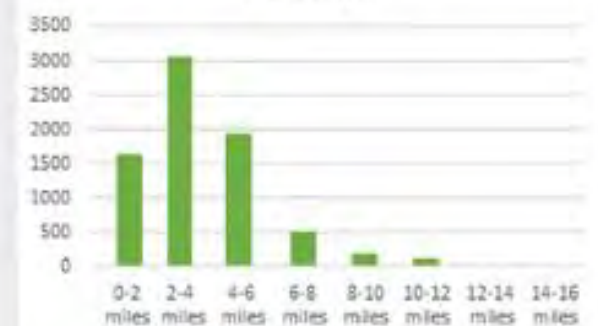


During this project, Pierce Transit learned a lot about first & last mile service in partnership with Lyft. Here are some of the results.

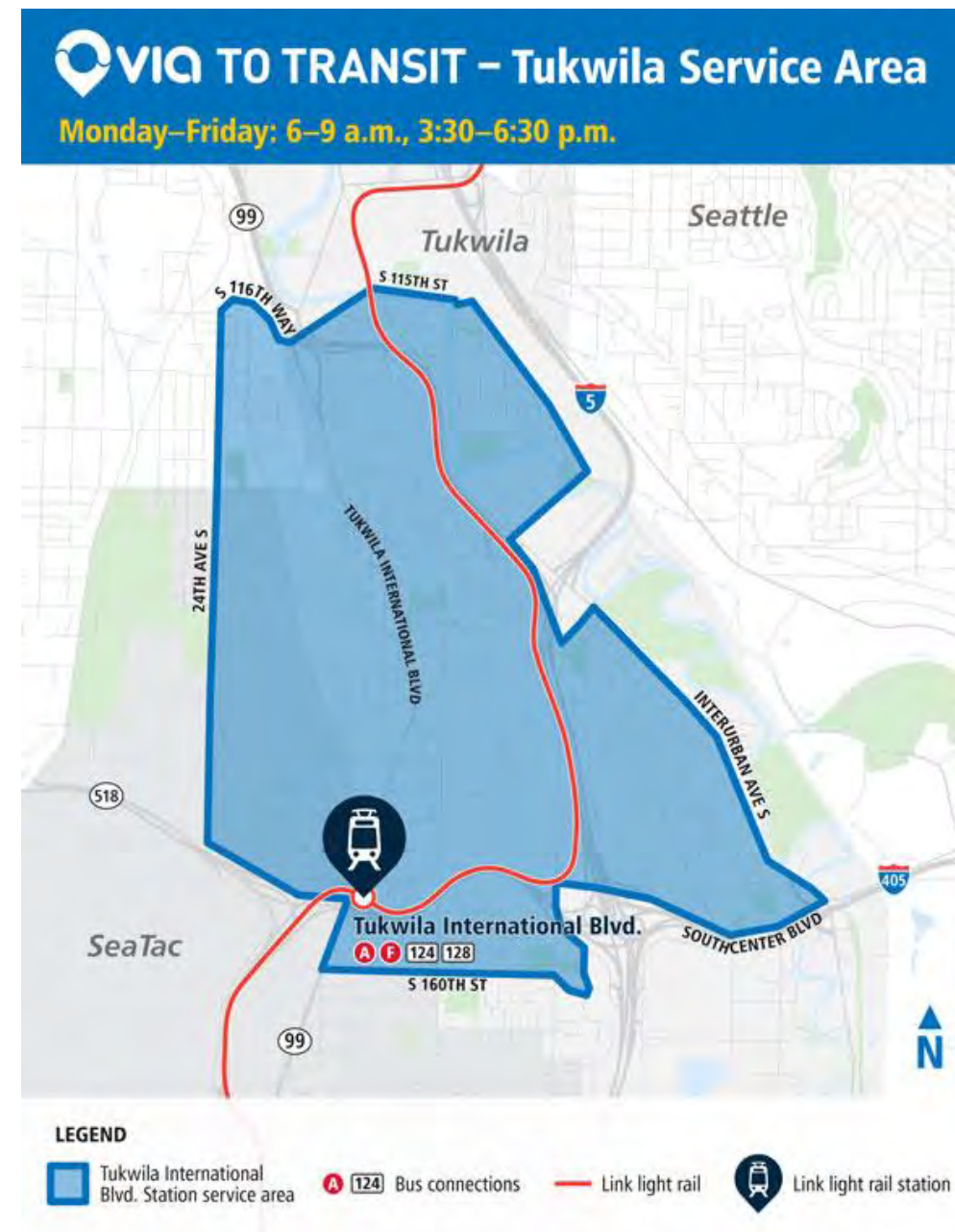
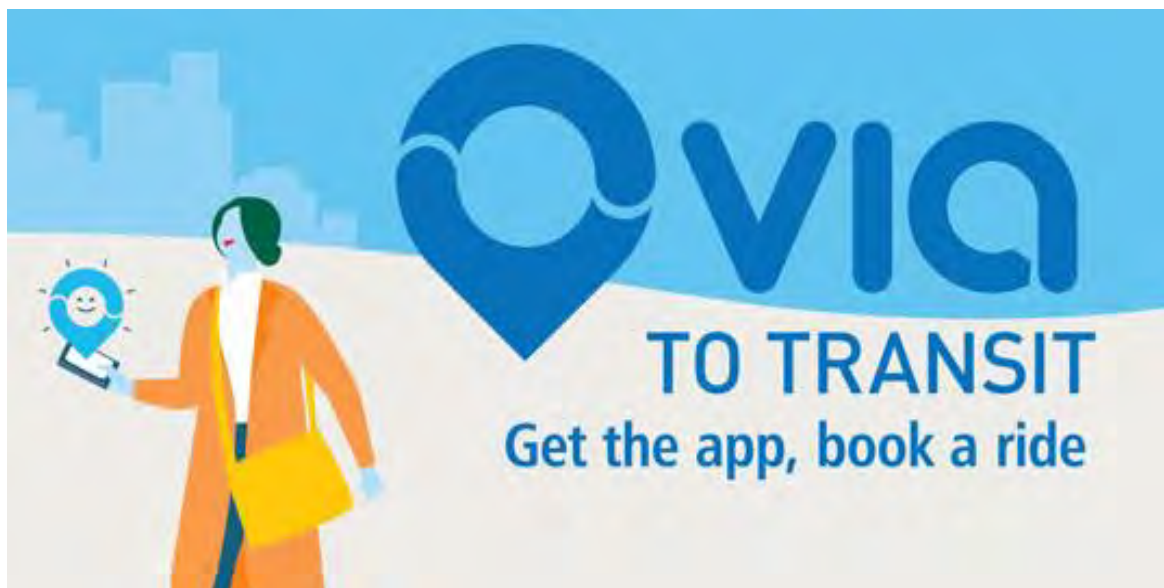
Trip Duration



Trip Length

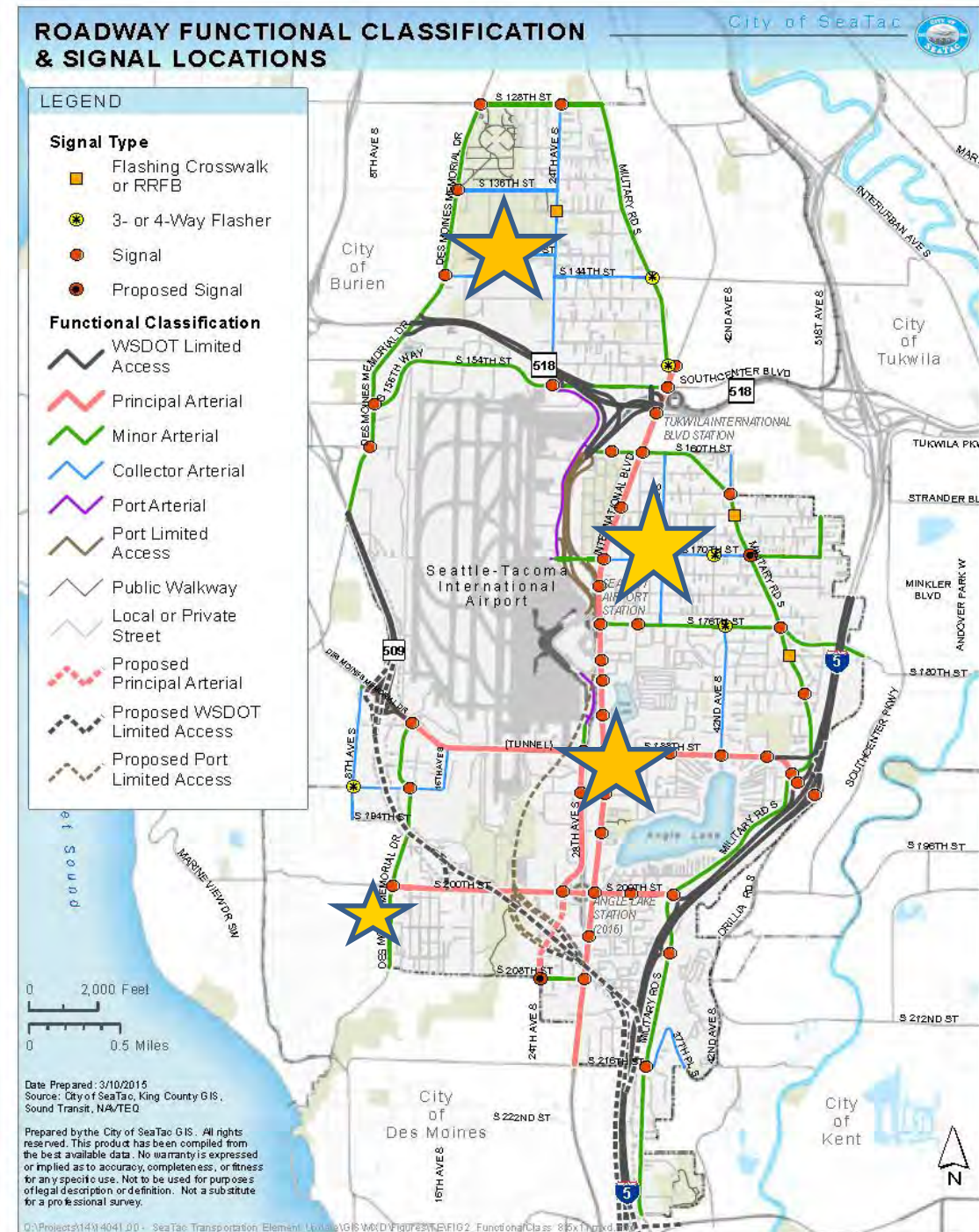




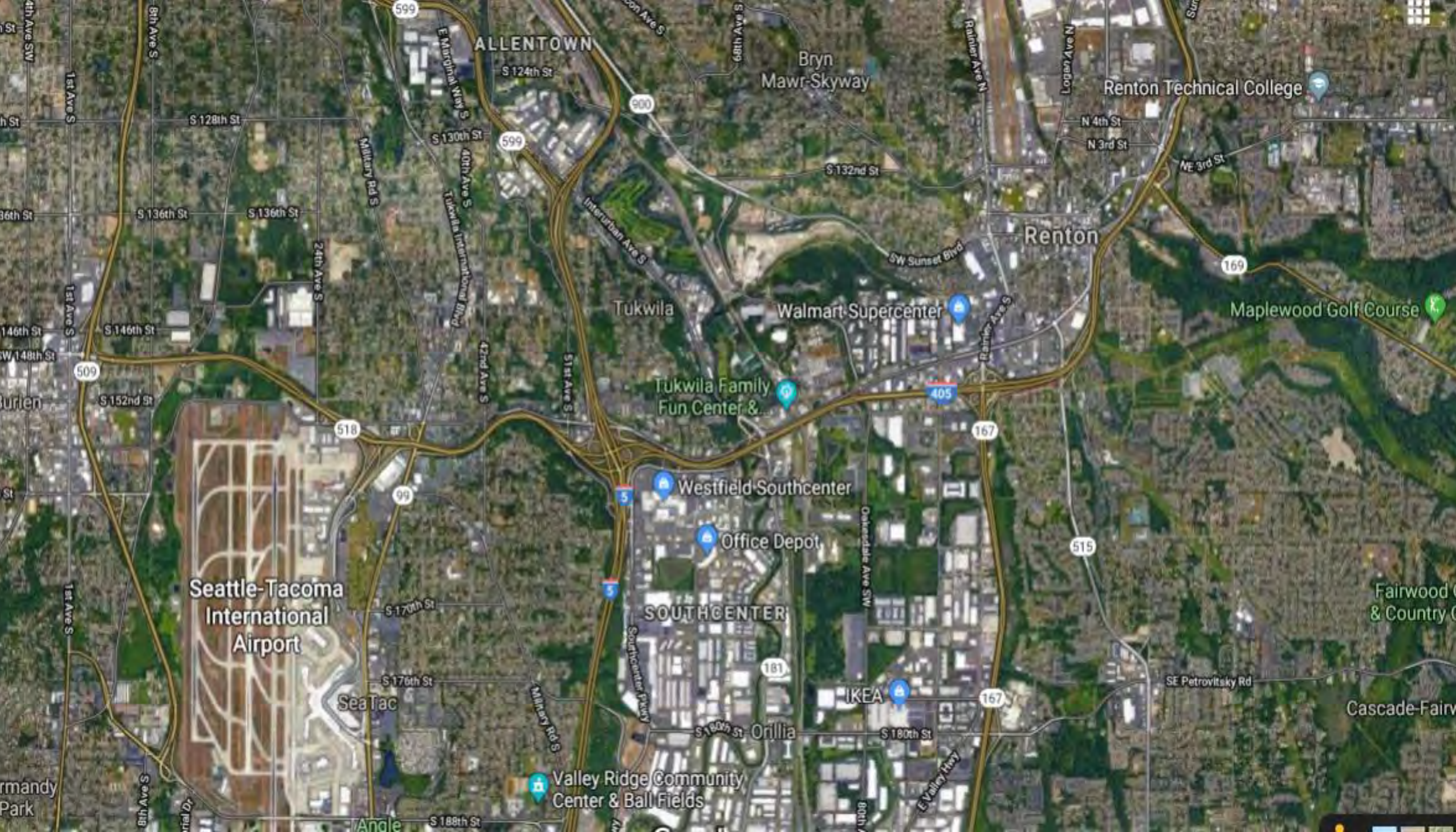




City of SeaTac  
Council has voted  
a resolution of  
support for  
deployment of  
electric automated  
shuttle routes in  
its residential  
areas









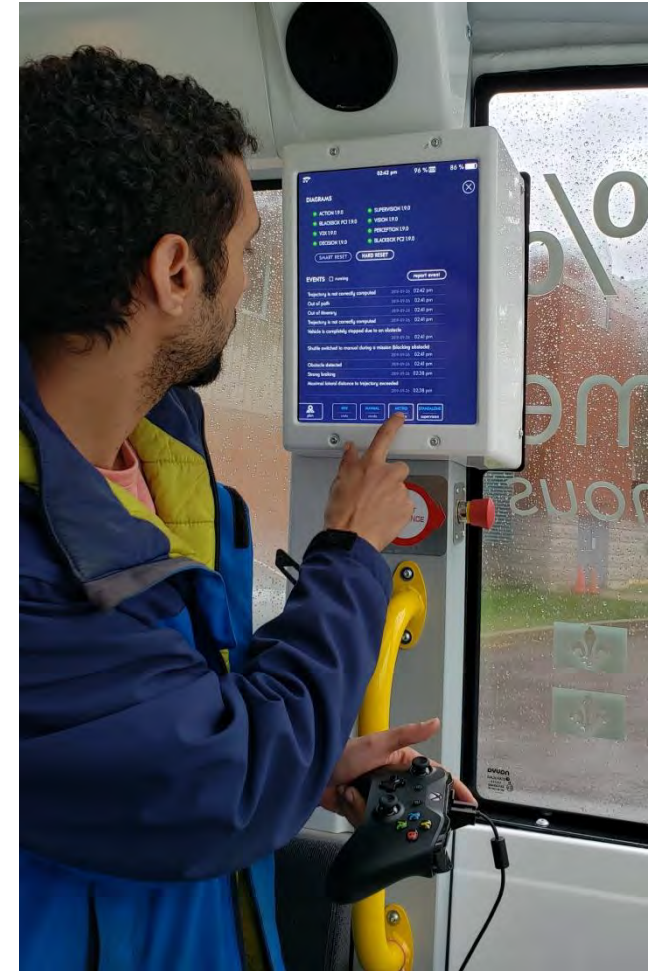
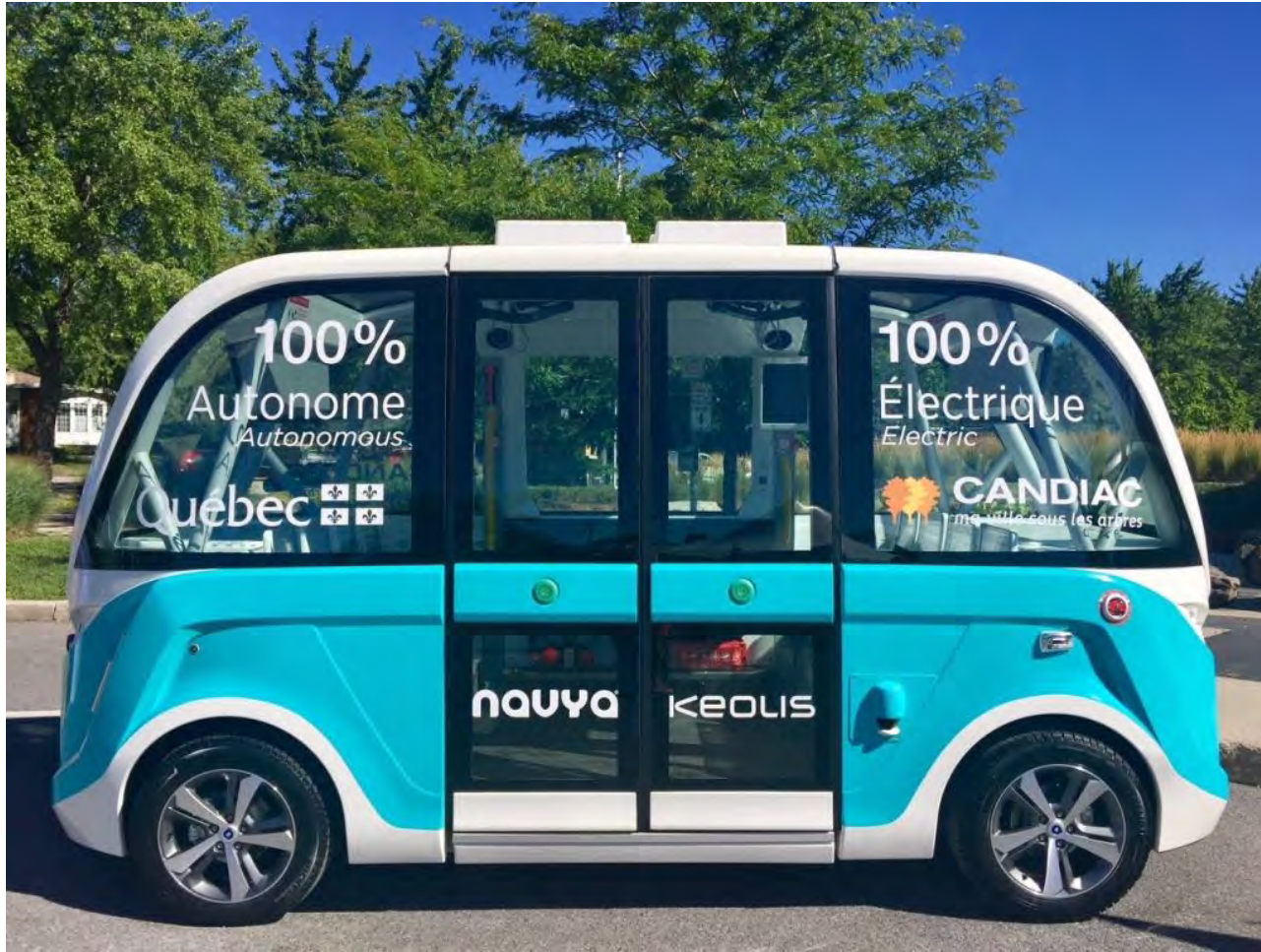
## **City of SeaTac and neighboring Tukwila and Burien have residential environments practical for safe operation of low-speed, first generation automated micro-transit**

- Purposely designed, wheelchair compatible, electric passenger vehicles with no driver
- On pre-selected, adapted, certified, existing roads
- Closely monitored & supervised fleet – remote but nearby
- Trials and pilots already underway worldwide





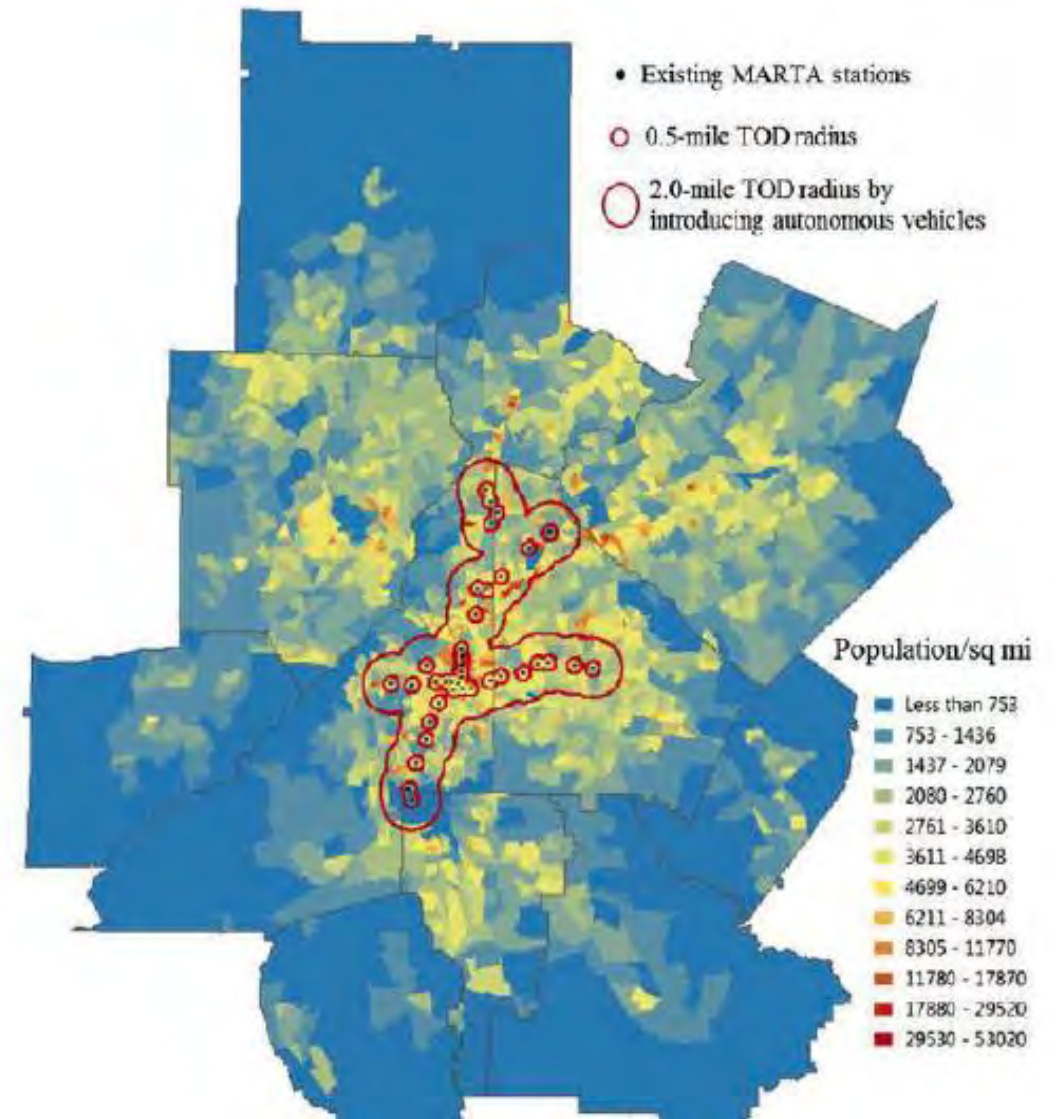
# EV Shuttles So Far Have Skilled, Licensed Operators





# Potential for AV shuttles expanding the total customer catchment around high-capacity transit stations

- Increase TOD radius from ½ mile to two miles
- Bring any resident to a transit hub using on-demand shuttles in same time as needed for a 10 minute walk.
- Increase TOD area of access to transit 16 fold



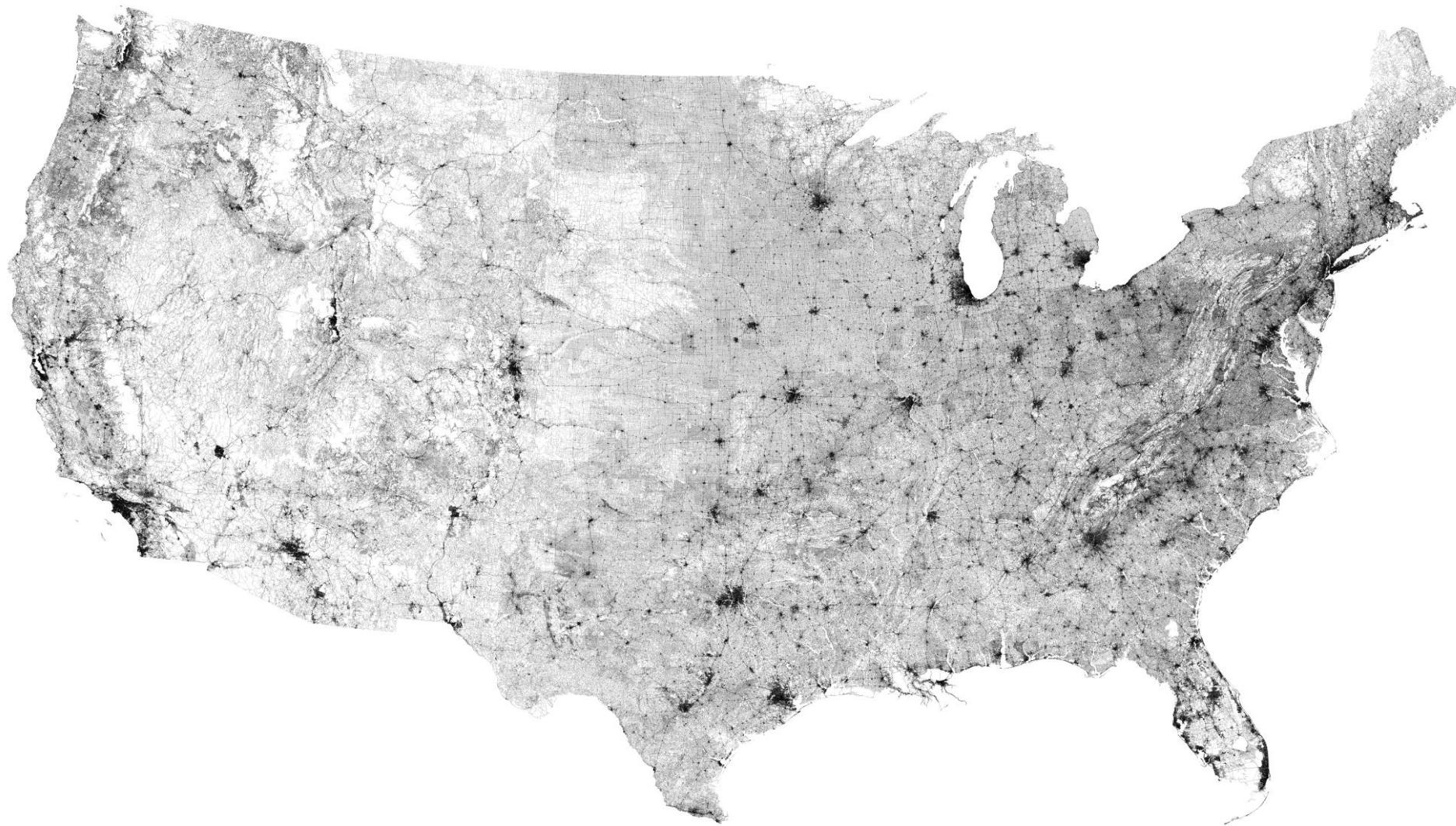
*Lu et al 2017, from End of Driving*



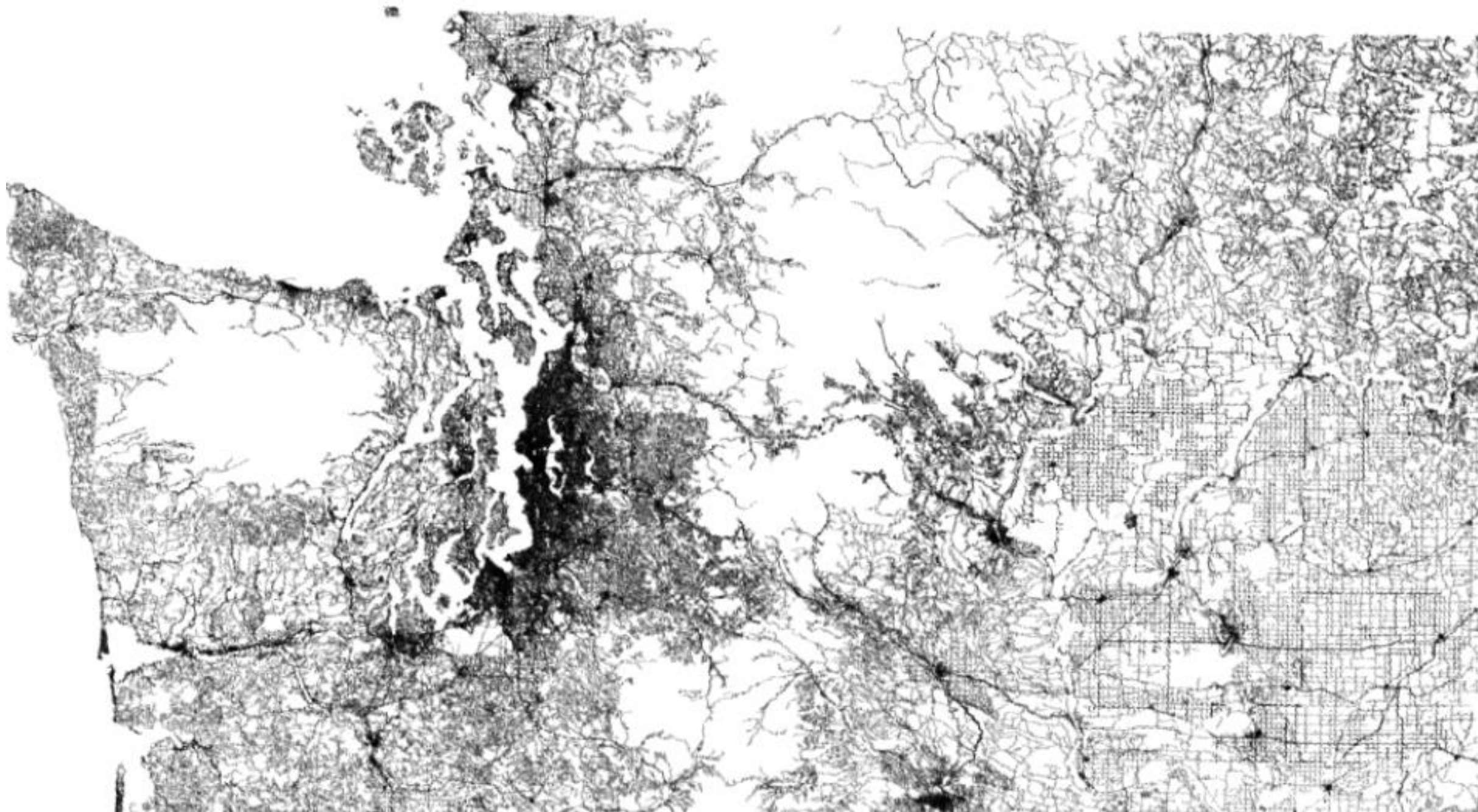
# Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **Public and government adopt these attitudes**
  - Understand mode split realities and small vehicle geographic reach
  - Larger vision of “public transit” to include small vehicle services
  - Support intermodalism: private, small vehicles  $\leftrightarrow$  heavy public transit
  - Support Universal Basic Mobility in small vehicle modes
  - Not all streets need to be “complete”
  - Insist that deployed Market 2 AVs be ultra safe
- **Maintain private sector and government work in progress**
  - Grow vehicle efficiency – electric powered cars
  - Embrace automated driver assistance systems
  - Deploy first/last mile microtransit with drivers for proof of business case and growth potential
  - **Fund and maintain roads via 18<sup>th</sup> amendment and RUC**
  - Manage curbs and sidewalks
  - Explore potential for congestion-clearing payments to commuters
  - Manage taxis and TNCs with trip-by-trip fees and subsidies



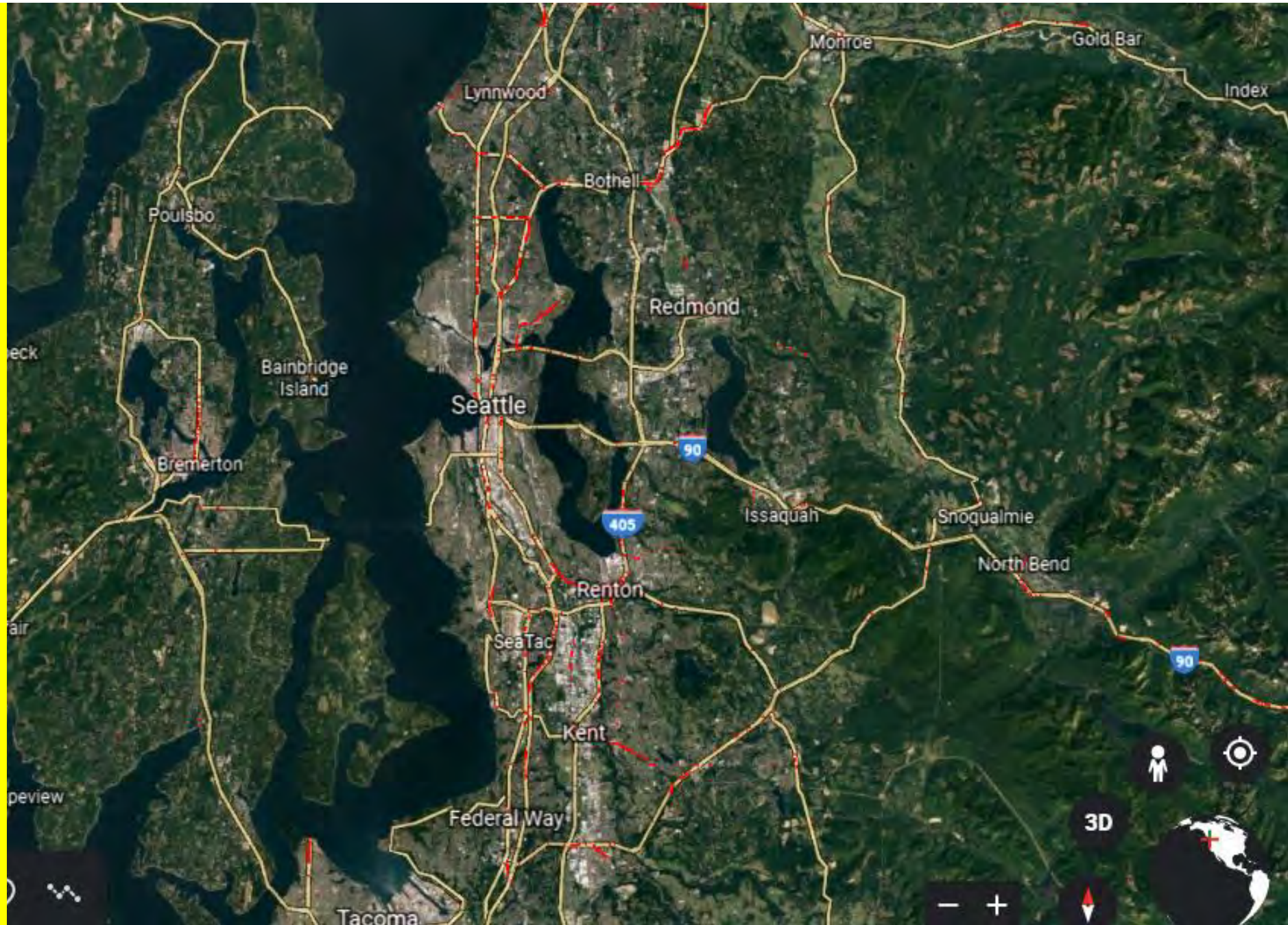








**Condition of  
Roads Bears  
on the  
Successful  
Utilization  
of  
Automated  
Road  
Vehicles**





# Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **Public and government adopt these attitudes**
  - Understand mode split realities and small vehicle geographic reach
  - Larger vision of “public transit” to include small vehicle services
  - Support intermodalism: private, small vehicles  $\leftrightarrow$  heavy public transit
  - Support Universal Basic Mobility in small vehicle modes
  - Not all streets need to be “complete”
  - Insist that deployed Market 2 AVs be ultra safe
- **Maintain private sector and government work in progress**
  - Grow vehicle efficiency – electric powered cars
  - Embrace automated driver assistance systems
  - Deploy first/last mile microtransit with drivers for proof of business case and growth potential
  - Fund and maintain roads via 18<sup>th</sup> amendment and RUC
  - **Manage curbs and sidewalks**
    - Explore potential for congestion-clearing payments to commuters
    - Manage taxis and TNCs with trip-by-trip fees and subsidies



# Infrastructural barriers to robotaxis

## Complete Streets

How will loading and unloading from shared AVs work in this picture?





The most pressing and immediate issues are already here...



Loading people



Loading goods

- A natural and long-standing problem that is worsening
- Mixed full- and semi-automation could worsen still



# Sidewalk and Curb Behaviour for Automated Vehicles: Arriving, Stopping, Parking, Waiting, and Loading

(ISO “new work initiative”)

## Changing curb & sidewalk

- Automation
- Precision
- Variety
- Demand increase
- Lower human attention to task
- Higher or lower conflict ratios?

**Level 0** — No structured consideration for access, parking, stopping, (un)loading

**Level 1** — access/park/stop/(un)load is managed • ADA (or equivalent) compliant

**Level 2** — *Assisted, partial* and monitored automation • Mostly manual

**Level 3** — *Conditional*, mixed and monitored automation • Assisted operation

**Level 4** — *Highly* automated/assisted operation • Guarded manual

**Level 5** — *Fully* automated • No manual vehicle or mobility device

*Early stage: Proposed only*



**More  
competition  
for curbside  
lanes and  
bike lanes  
from robotic  
package  
delivery.**

## Autonomous Delivery Robots Find Place in Michigan Bike Lanes

*A company in Ann Arbor, Mich., is testing the hypothesis that full-sized autonomous vehicles are not the answer to making short-distance food or grocery deliveries, and is instead betting on small electric vehicles.*

BY SKIP DESCANT / JULY 22, 2019



*An REV-1 autonomous delivery vehicle in front of a restaurant in Ann Arbor, Mich., ready for a delivery.*

COURTESY REFRACTION AI





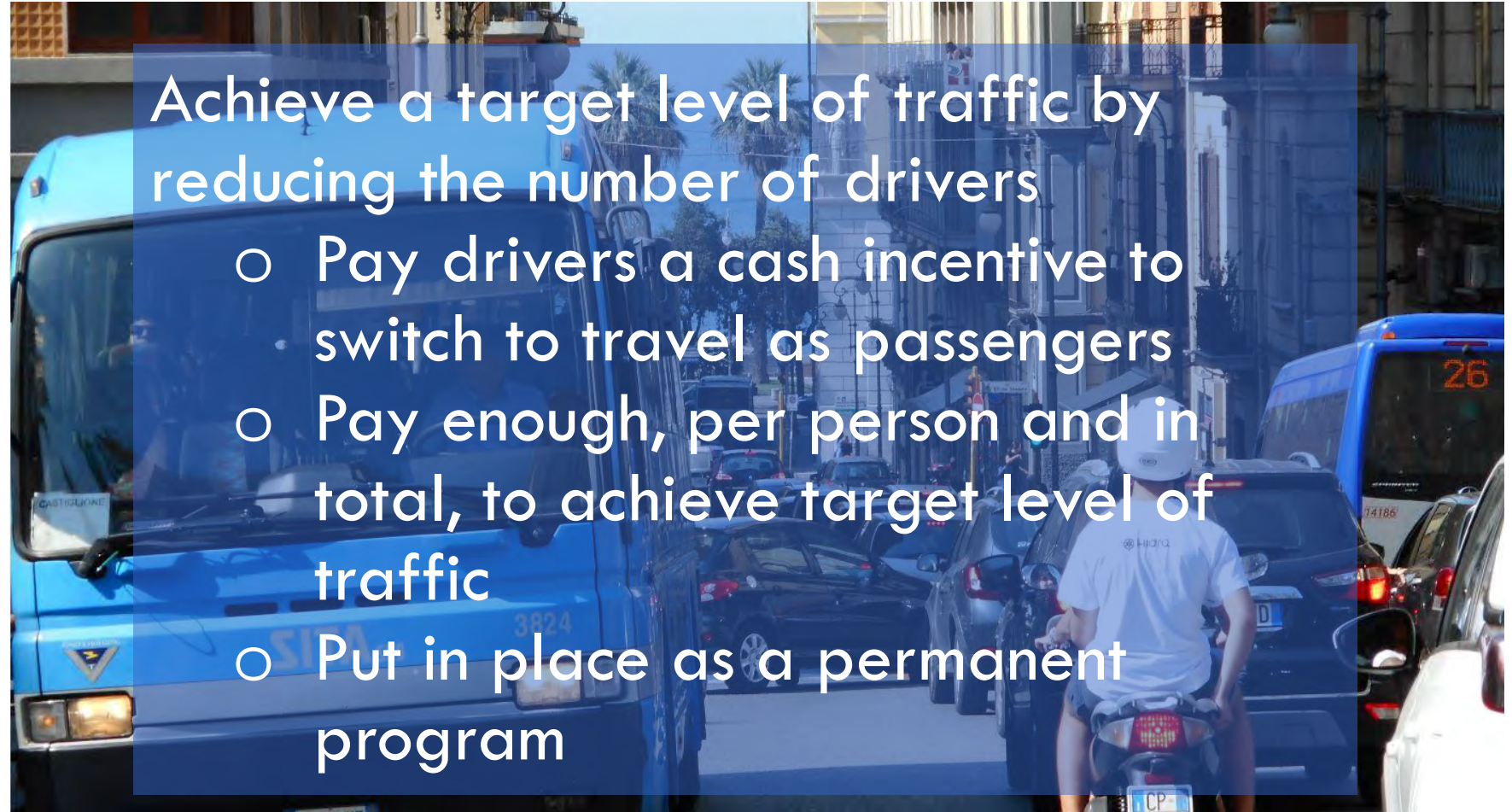
# Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **Public and government adopt these attitudes**
  - Understand mode split realities and small vehicle geographic reach
  - Larger vision of “public transit” to include small vehicle services
  - Support intermodalism: private, small vehicles  $\leftrightarrow$  heavy public transit
  - Support Universal Basic Mobility in small vehicle modes
  - Not all streets need to be “complete”
  - Insist that deployed Market 2 AVs be ultra safe
- **Maintain private sector and government work in progress**
  - Grow vehicle efficiency – electric powered cars
  - Embrace automated driver assistance systems
  - Deploy first/last mile microtransit with drivers for proof of business case and growth potential
  - Fund and maintain roads via 18<sup>th</sup> amendment and RUC
  - Manage curbs and sidewalks
  - **Explore potential for congestion-clearing payments to commuters**
  - Manage taxis and TNCs with trip-by-trip fees and subsidies



# Example: Promotion of Vehicle Occupancy Sharing

Title: “Congestion Clearing  
Payments to Passengers”  
Research Project 1817  
Funded by Mineta  
Transportation Institute at  
San Jose State University,  
2018-19  
Paul Minett, Principal  
Investigator



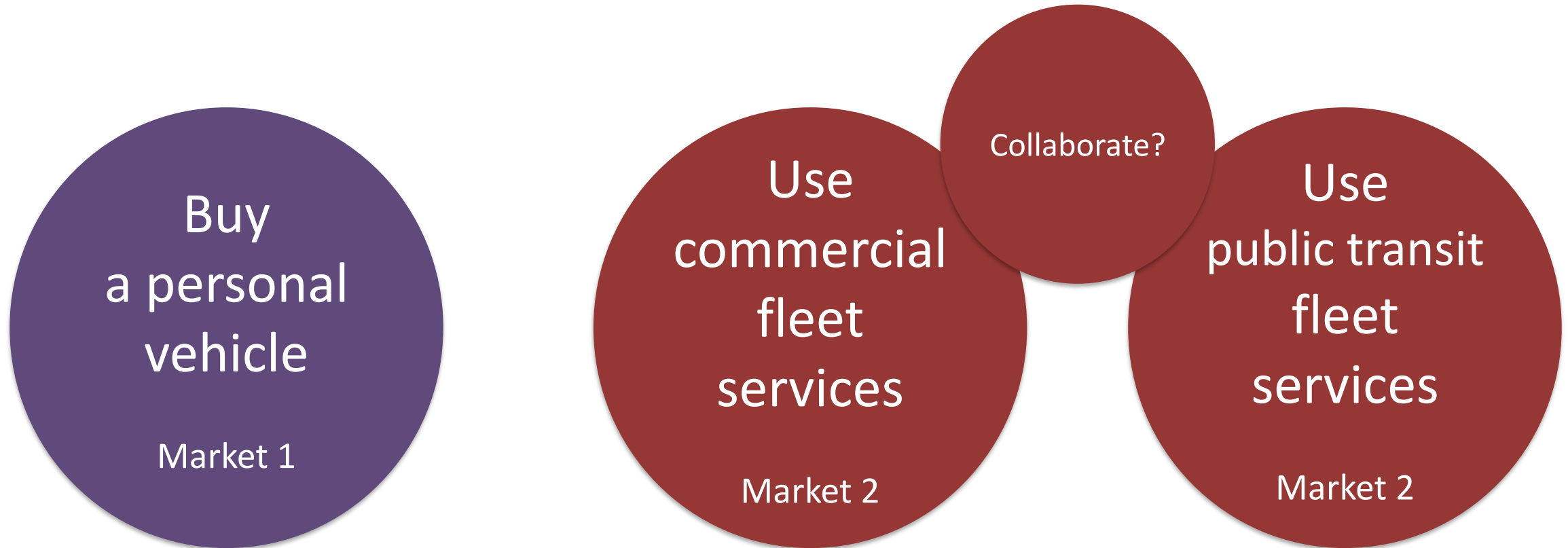


# Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **Public and government adopt these attitudes**
  - Understand mode split realities and small vehicle geographic reach
  - Larger vision of “public transit” to include small vehicle services
  - Support intermodalism: private, small vehicles  $\leftrightarrow$  heavy public transit
  - Support Universal Basic Mobility in small vehicle modes
  - Not all streets need to be “complete”
  - Insist that deployed Market 2 AVs be ultra safe
- **Maintain private sector and government work in progress**
  - Grow vehicle efficiency – electric powered cars
  - Embrace automated driver assistance systems
  - Deploy first/last mile microtransit with drivers for proof of business case and growth potential
  - Fund and maintain roads via 18<sup>th</sup> amendment and RUC
  - Manage curbs and sidewalks
  - Explore potential for congestion-clearing payments to commuters
  - **Manage taxis and TNCs with trip-by-trip fees and subsidies**



# Future of automated vehicle mobility



“...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)*



## Software-defined Transit

*Harmonization Management System (HMS)*



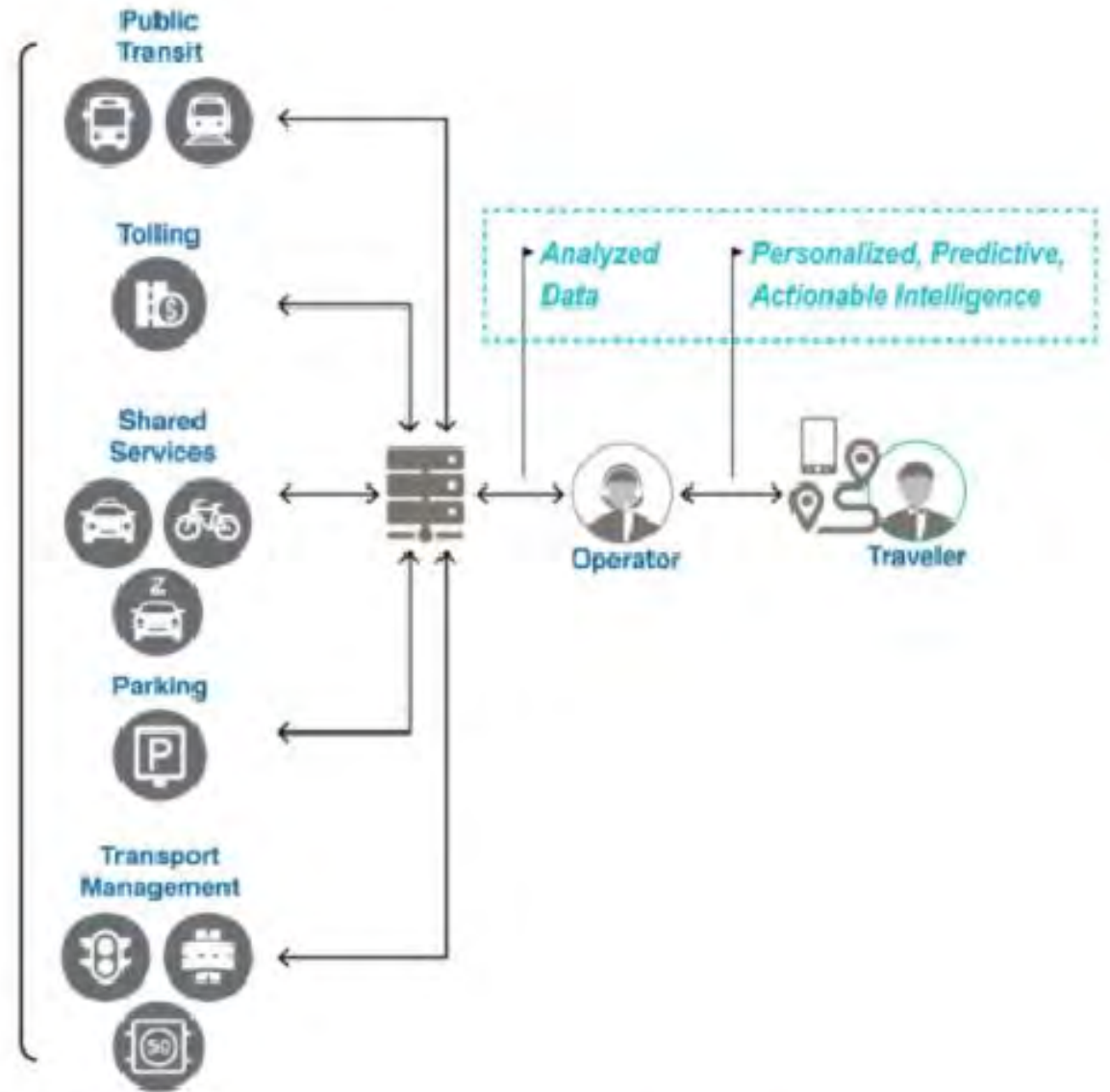
MaaS = Mobility as a Service

MOD = Mobility on Demand

Formerly: Dial-a-Ride

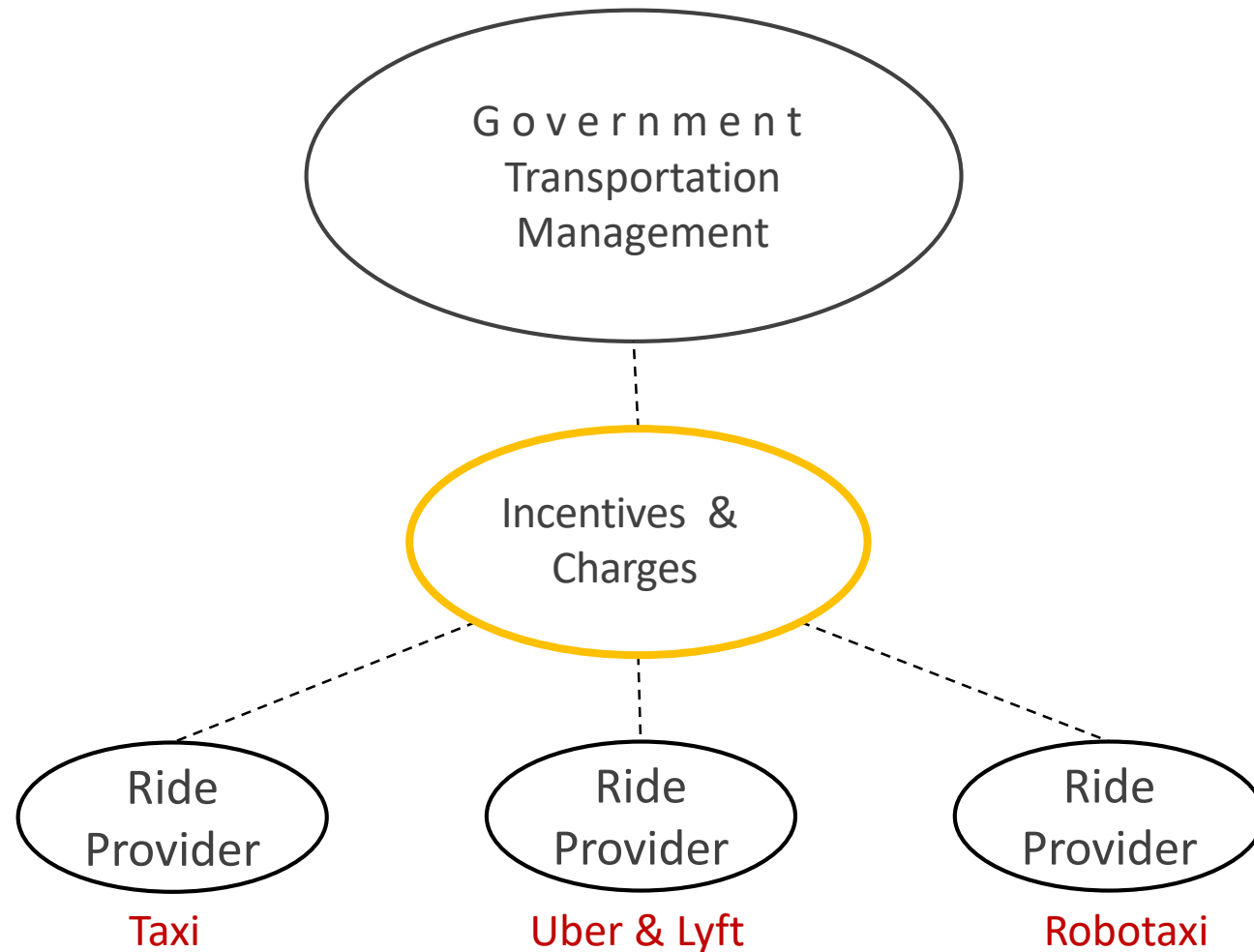
Earlier: Call or flag a cab

## Emerging Market Approaches to MaaS





# New concept: Harmonization Management to influence private ride delivery priorities





## HMS

Performance-based governance for growing fleets of for-hire vehicles (FHVs) enables cities and regions to...

*Creates an open marketplace for mobility for hire*

Today

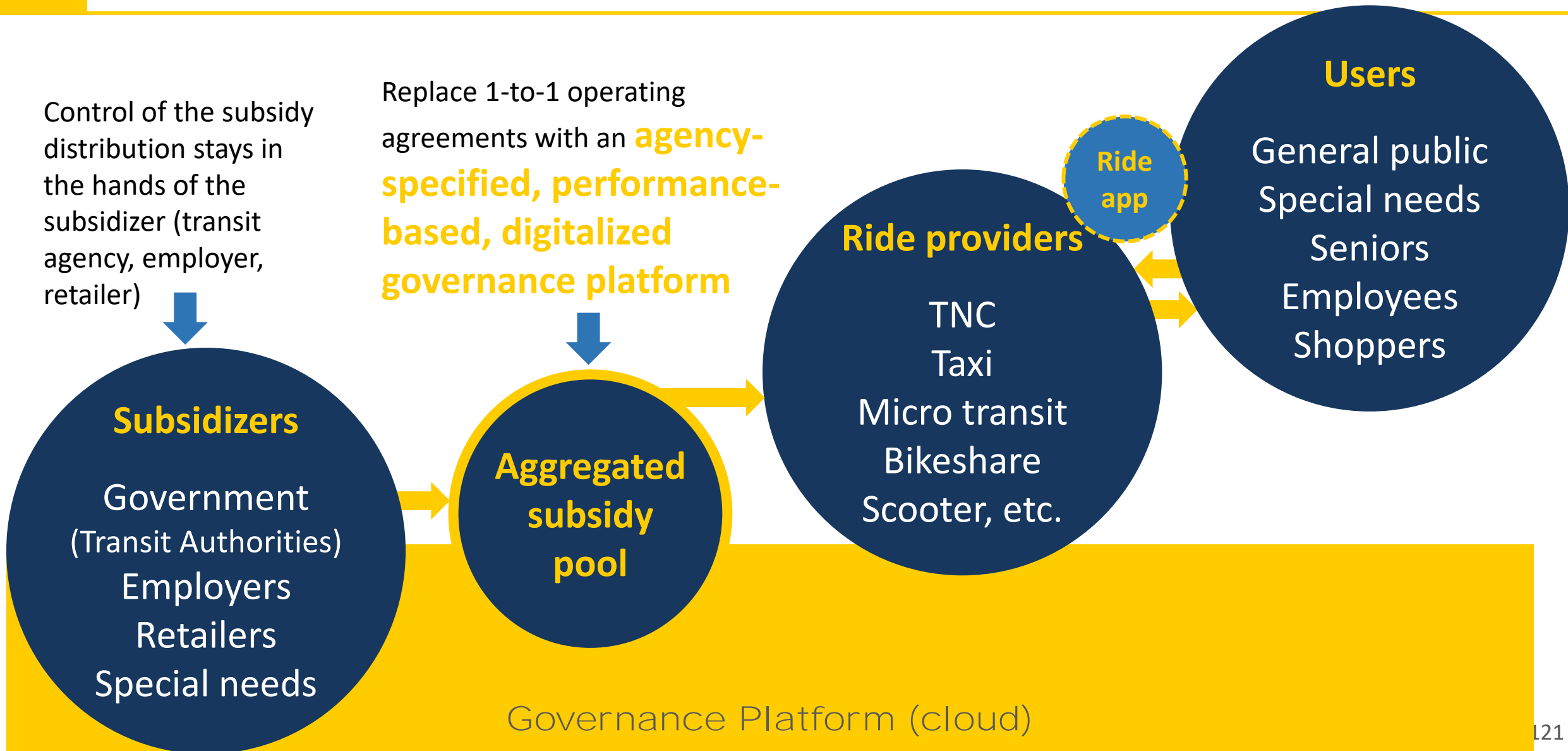
...enhance and extend transit services via collaboration with  
**commercial ride providers**

Tomorrow

...create a path to the governance of massive fleets of  
**automated vehicles**



# Transit-provider partnership





# HMS Now in Development!

**HMS is a cloud-based platform to manage the performance of for-hire urban vehicle fleets**

- ❑ **Overseen by government**
- ❑ **To deliver targeted incentives**
- ❑ **And collect fees such as CBD tolling**
- ❑ **To/from ride providers**
- ❑ **On per-trip basis**





# Full Potential of Future Robotaxis Achievable with Trip-Based Subsidies and Fees Applied to the For-Hire Vehicles of Today

Project 1903  
August 2019

John Niles, M.S.





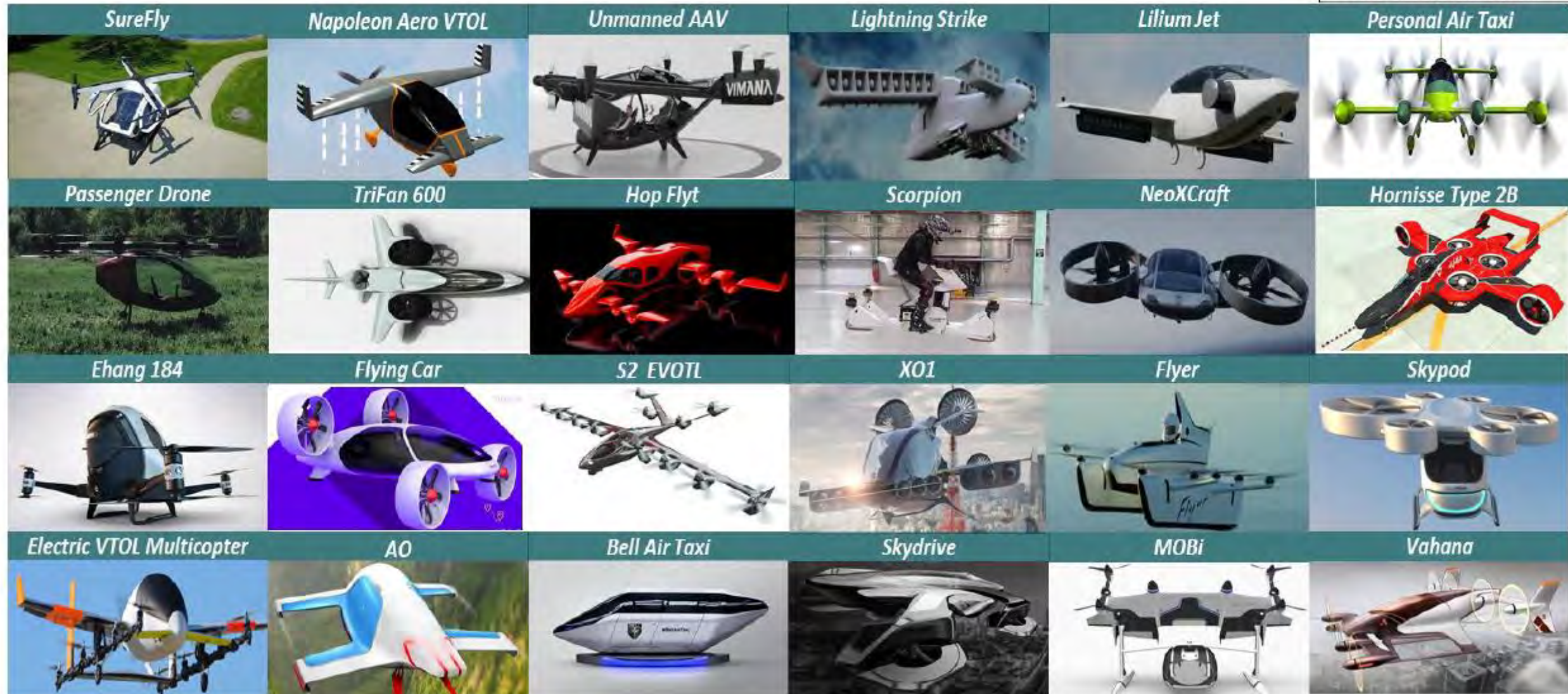
# Menu of Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **Public and government adopt these attitudes**
  - Understand mode split realities and small vehicle geographic reach
  - Larger vision of “public transit” to include small vehicle services
  - Support intermodalism: private, small vehicles <- > heavy public transit
  - Support Universal Basic Mobility in small vehicle modes
  - Not all streets need to be “complete”
  - Insist that deployed Market 2 AVs be ultra safe
- **Maintain private sector and government work in progress**
  - Grow vehicle efficiency – electric powered cars
  - Embrace automated driver assistance systems
  - Deploy first/last mile microtransit with drivers for proof of business case and growth potential
  - Fund and maintain roads via 18<sup>th</sup> amendment and RUC
  - Manage curbs and sidewalks
  - Explore potential for congestion-clearing payments to commuters
  - Manage taxis and TNCs with trip-by-trip fees and subsidies



# Robotic Flying Cars, Buses, & Freighters: Technically Easier Than Robotic Cars, Buses, & Trucks on Roads

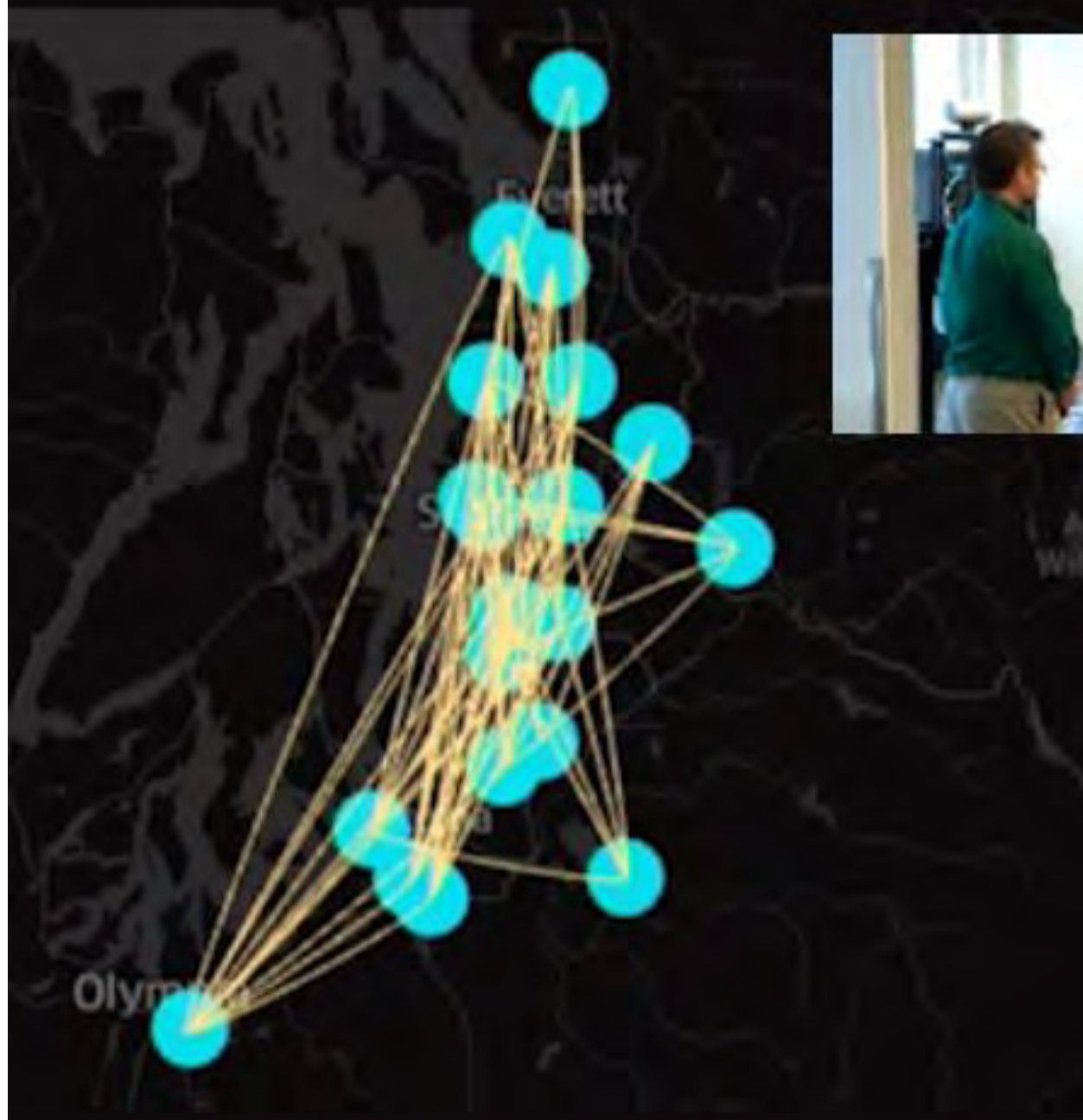
NON-EXHAUSTIVE





# Uber Elevate presentation in Seattle, 2017

## VTOL Network in Seattle





# Why we need to talk about Urban Air Mobility now in the Pacific NW?

1. Transportation grid in our region is becoming

## Urban Air Mobility in the Puget Sound Region

November 2019

Port  
of Seattle

TIM TOERBER

Urban Air Mobility Advisory Committee Chair

PORT OF SEATTLE

SEATTLE-TACOMA INTERNATIONAL AIRPORT

Port  
of Seattle

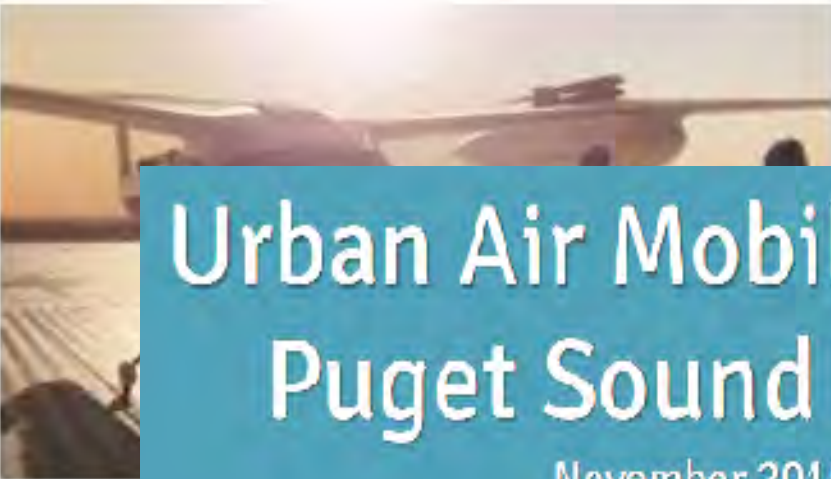
5. Regional **vision plans** for future transportation should include UAM concepts

SEATTLE-TACOMA INTERNATIONAL AIRPORT

Port  
of Seattle

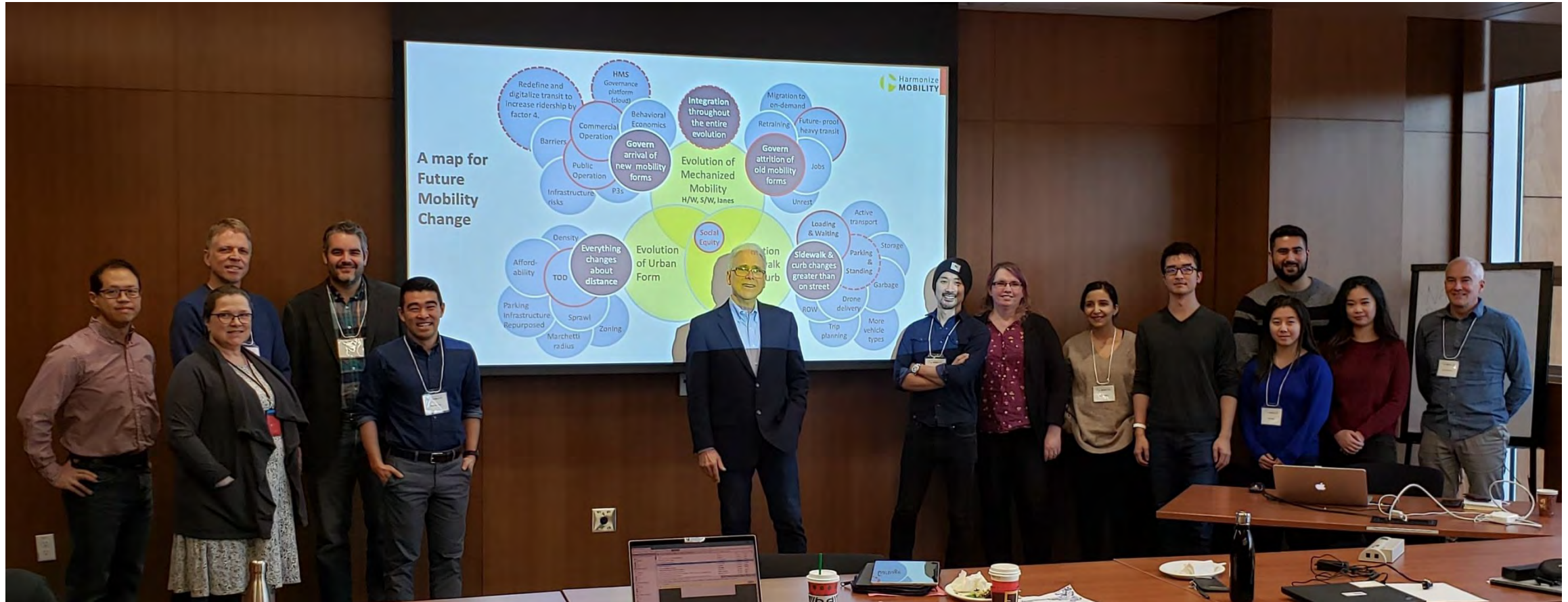


Gannett Fleming Skyport





# “End of Driving: Get Ready” Course has been taught in Canada and New Zealand





## Course: Getting Ready for Automated On-Demand Transit

### Contexts

- ❑ Two Markets
- ❑ Multiple Transitions
- ❑ Conflicting Narratives
- ❑ Contexts of Change
- Digitalization and New Mobility

### Challenges

- Diffusion
- Barriers
- Sidewalk & Curb  
+Mobility Justice
- ❑ Infrastructure Risk
- ❑ 50% City

### Opportunities

- ❑ Land Use (including TOD)
- ❑ Autonomous Transit Fleets
- Software-Defined Transit
- Behavioural Economics
- What About Mass Transit?
- One City's Way Forward

Context

| Diffusion

| Deployment

| Tools



**Thank You!**

**Any Questions?**



Questions or comments to John Niles at [jniles@alum.mit.edu](mailto:jniles@alum.mit.edu) or call 206-781-4475



# Menu of Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **Public and government adopt these attitudes**
  - Understand mode split realities and small vehicle geographic reach
  - Larger vision of “public transit” to include small vehicle services
  - Support intermodalism: private, small vehicles <- > heavy public transit
  - Support Universal Basic Mobility in small vehicle modes
  - Not all streets need to be “complete”
  - Insist that deployed Market 2 AVs be ultra safe
- **Maintain private sector and government work in progress**
  - Grow vehicle efficiency – electric powered cars
  - Embrace automated driver assistance systems
  - Deploy first/last mile microtransit with drivers for proof of business case and growth potential
  - Fund and maintain roads via 18<sup>th</sup> amendment and RUC
  - Manage curbs and sidewalks
  - Explore potential for congestion-clearing payments to commuters
  - Manage taxis and TNCs with trip-by-trip fees and subsidies