

Perspectives on Vehicle Automation

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

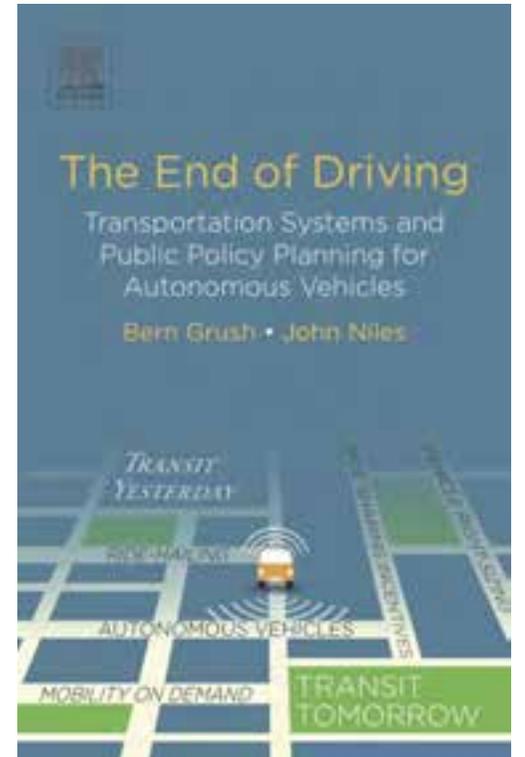
Presentation to Washington State Transportation Commission, December 17, 2019

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

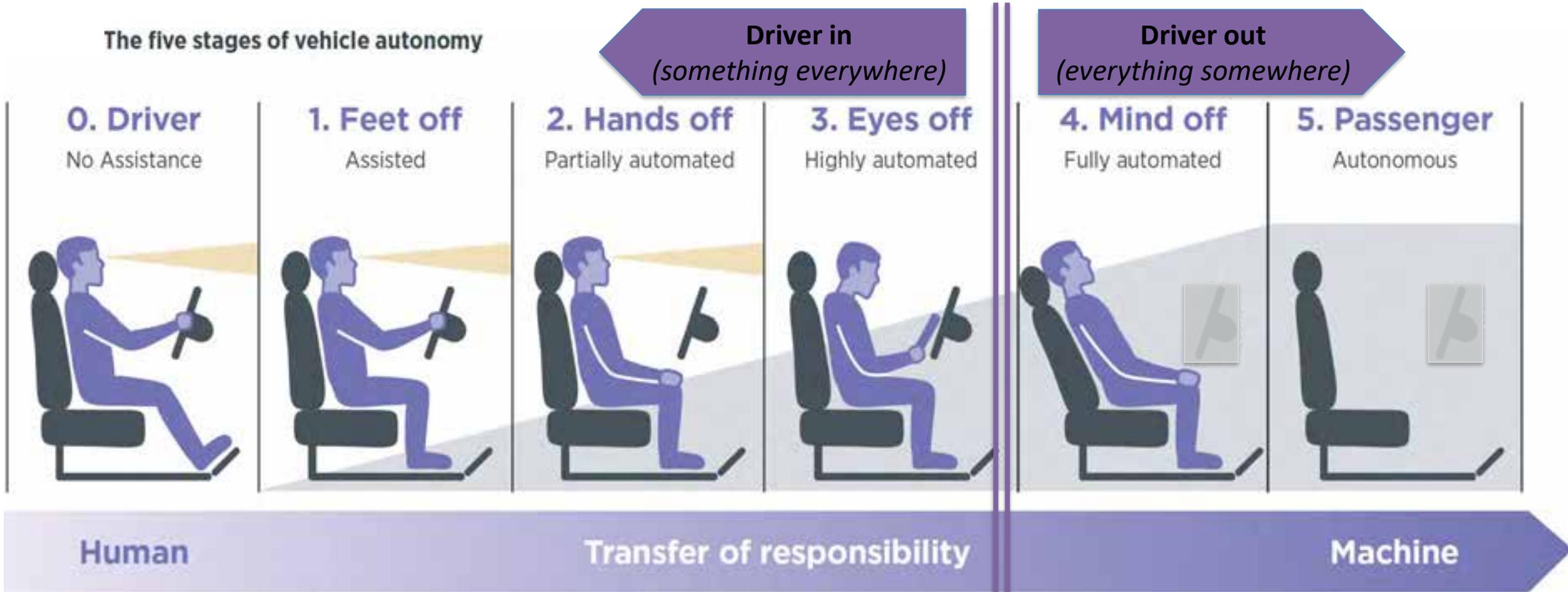
The Great Horse
Manure Crisis 1894

2010: Save us from cars!



Injuries
Fatalities
Health
Pollution
GHG
Congestion
Sprawl
Inequity
Habitat loss

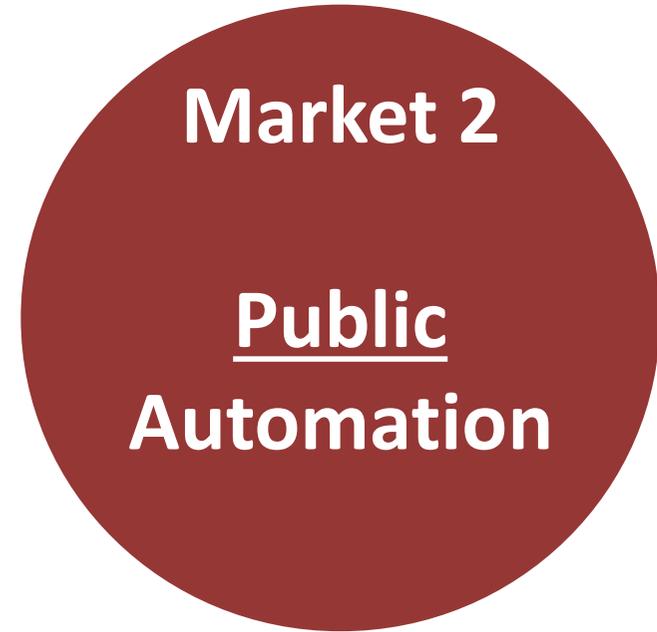
Simplistic Market Buzz Since 2013



Two Kinds of Automated Vehicles are Happening

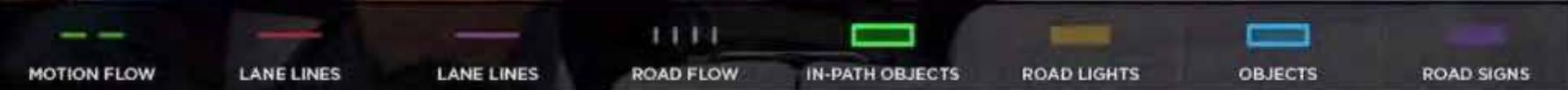


People buying CARS



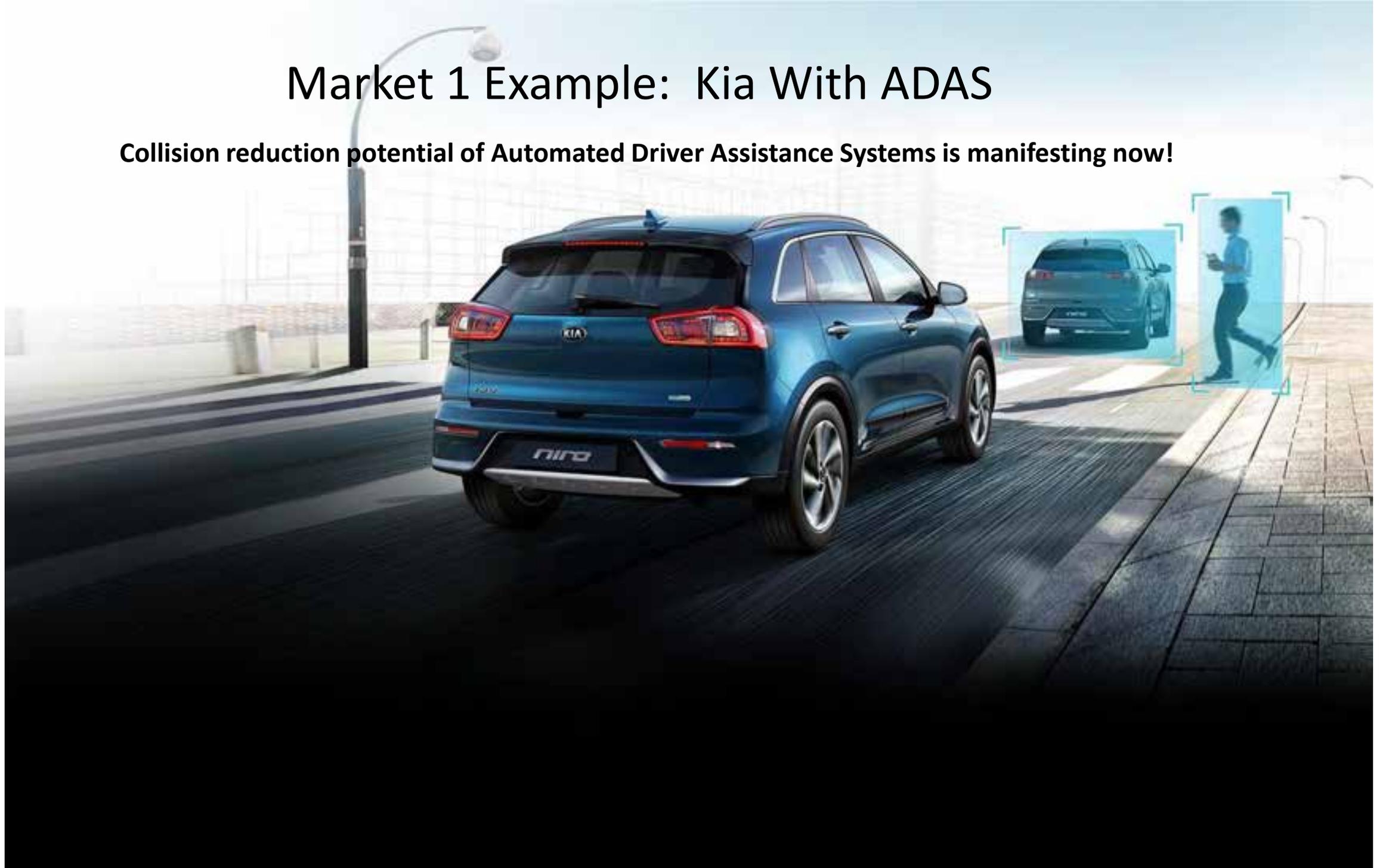
People buying RIDES

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

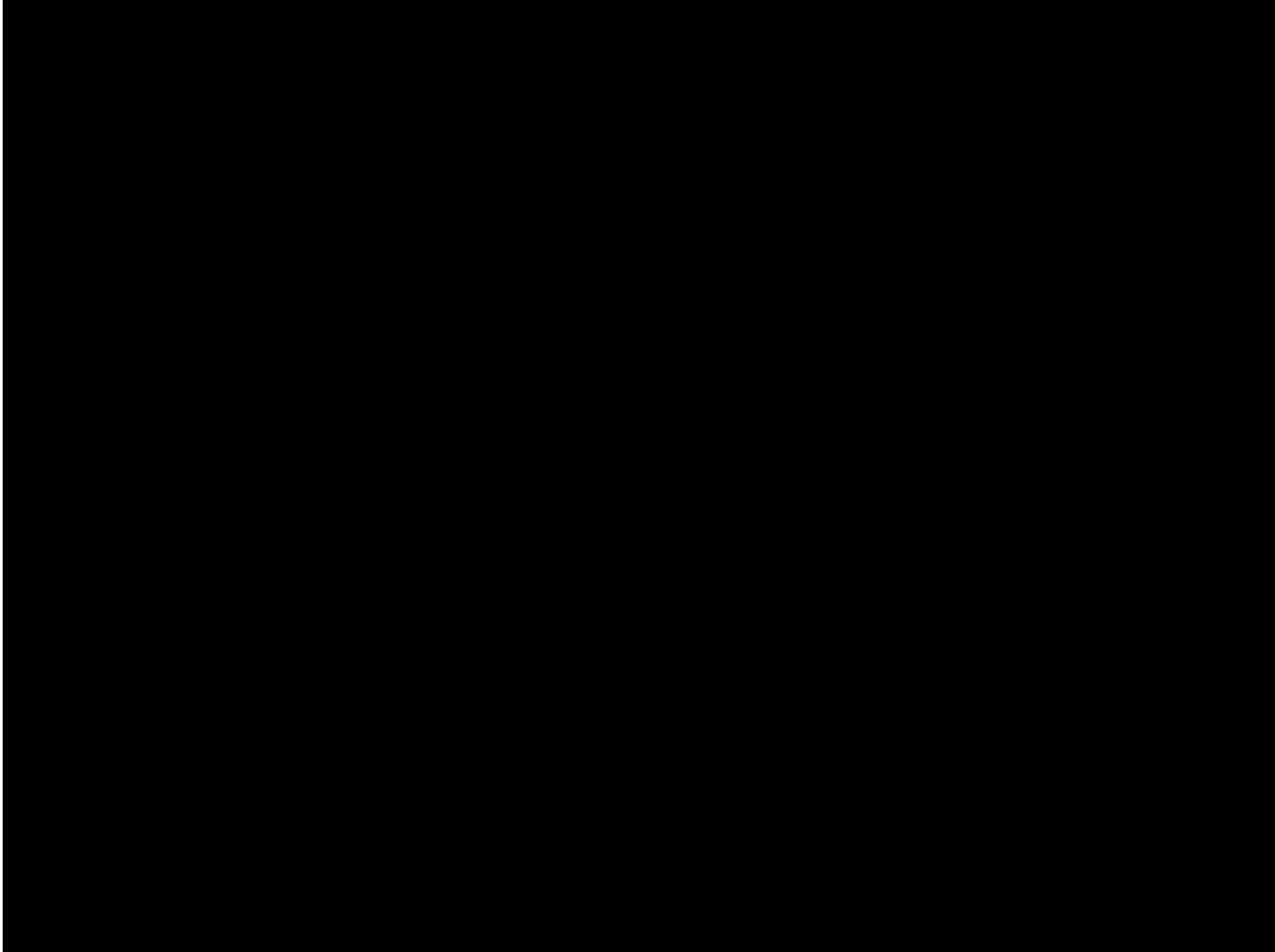
Thomas Köhn
Matthias Gottlieb
Chair for Information Systems
Technical University of Munich
Munich, Germany
{thomas.koehn|gottlieb}@in.tum.de

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





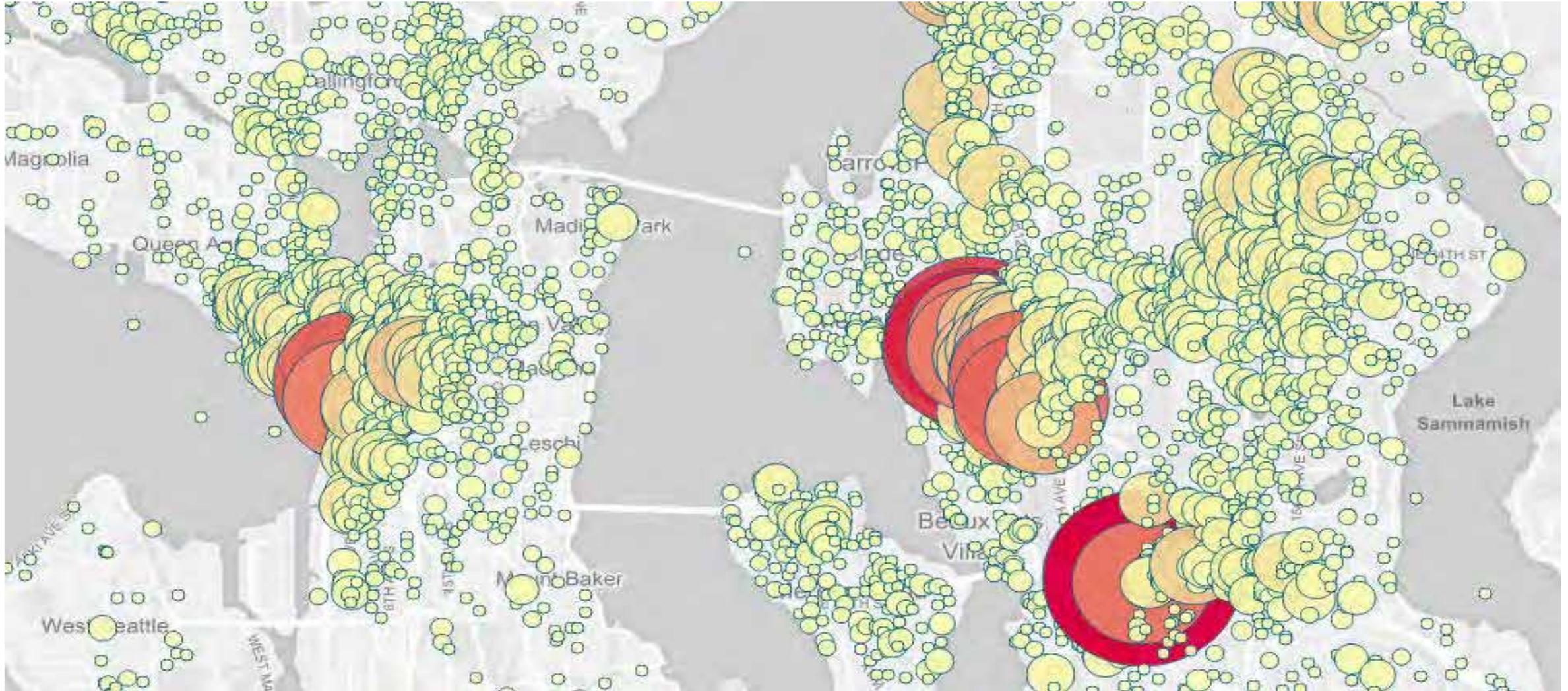
Market 2 – Ride Buying

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 Market 1 Self-driving: Can go anywhere if you drive	
	No	Level 5 Far future 2050-2075 +	Level 4 Market 2 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

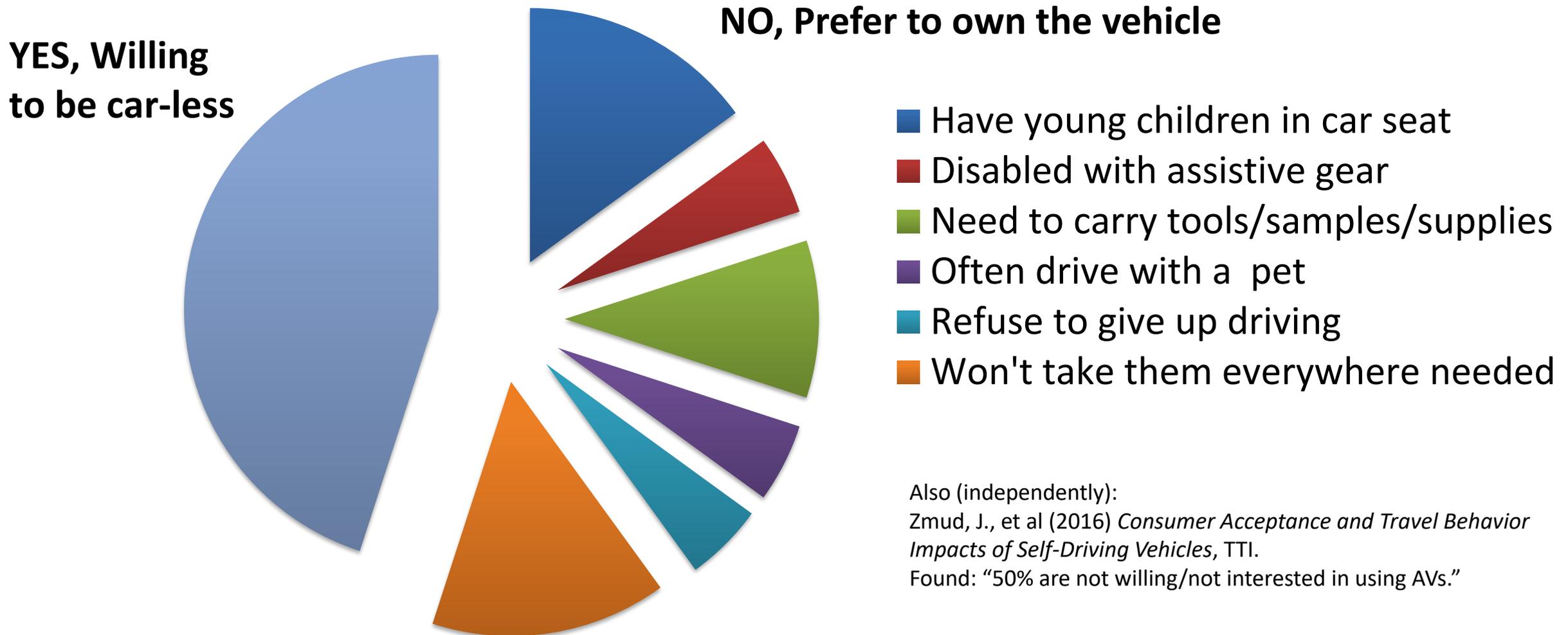


Transportation Services

Will ride-buying dominate?



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>

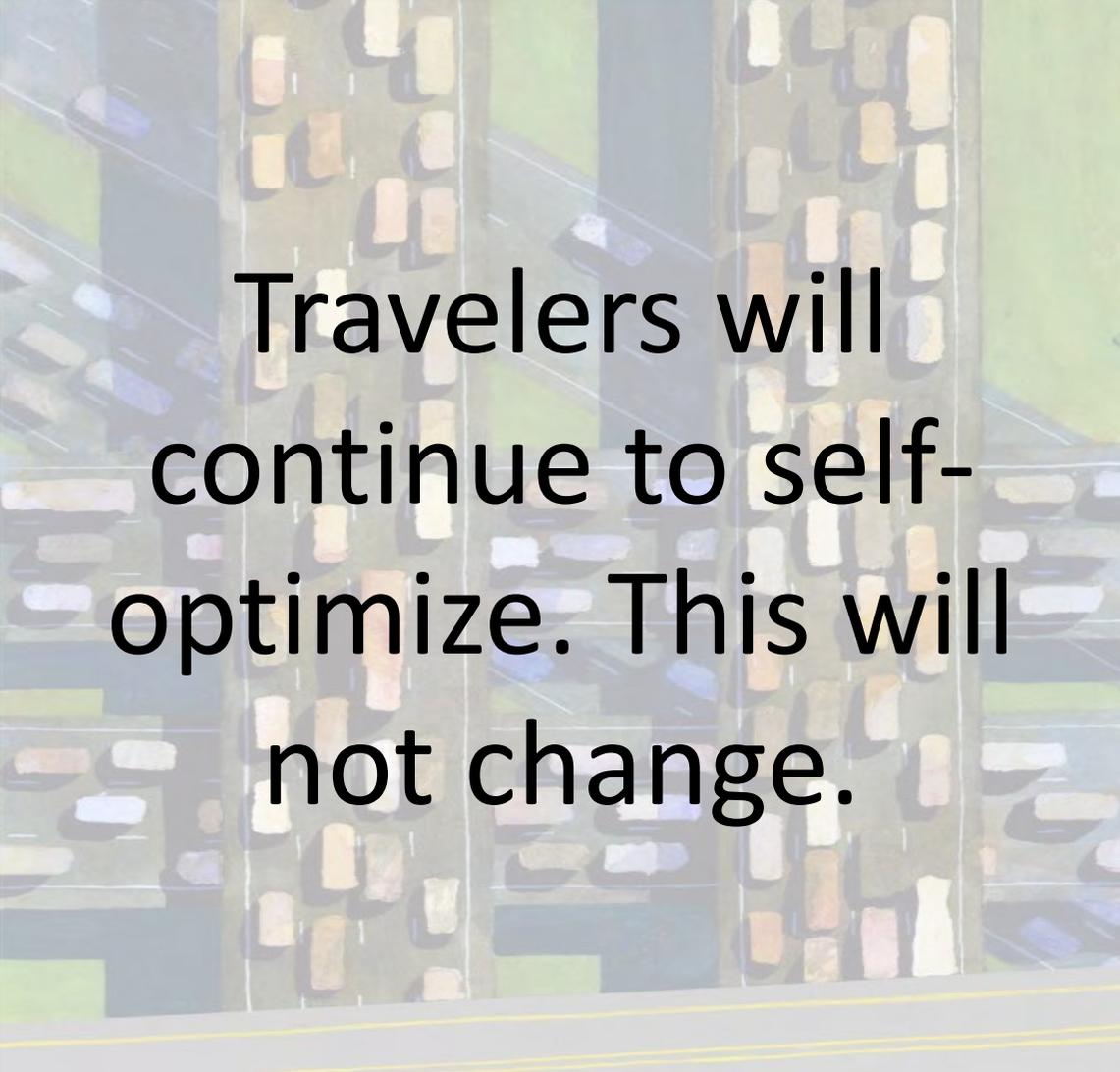
Will car sharing and ride sharing preserve these features of automobile ownership that make it so popular?

- 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

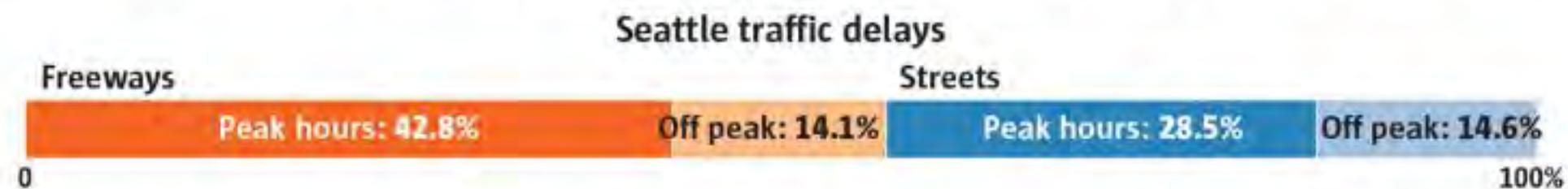
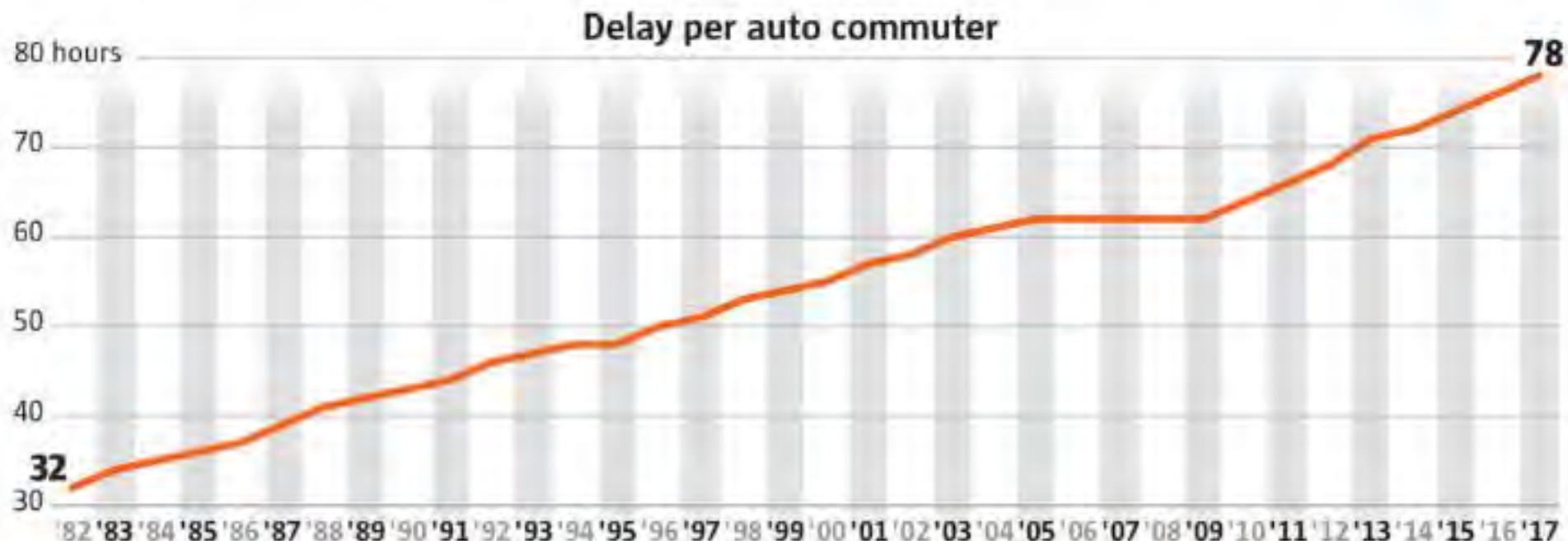
No

It depends

Each person decides. We live in a democracy.

Seattle congestion over time

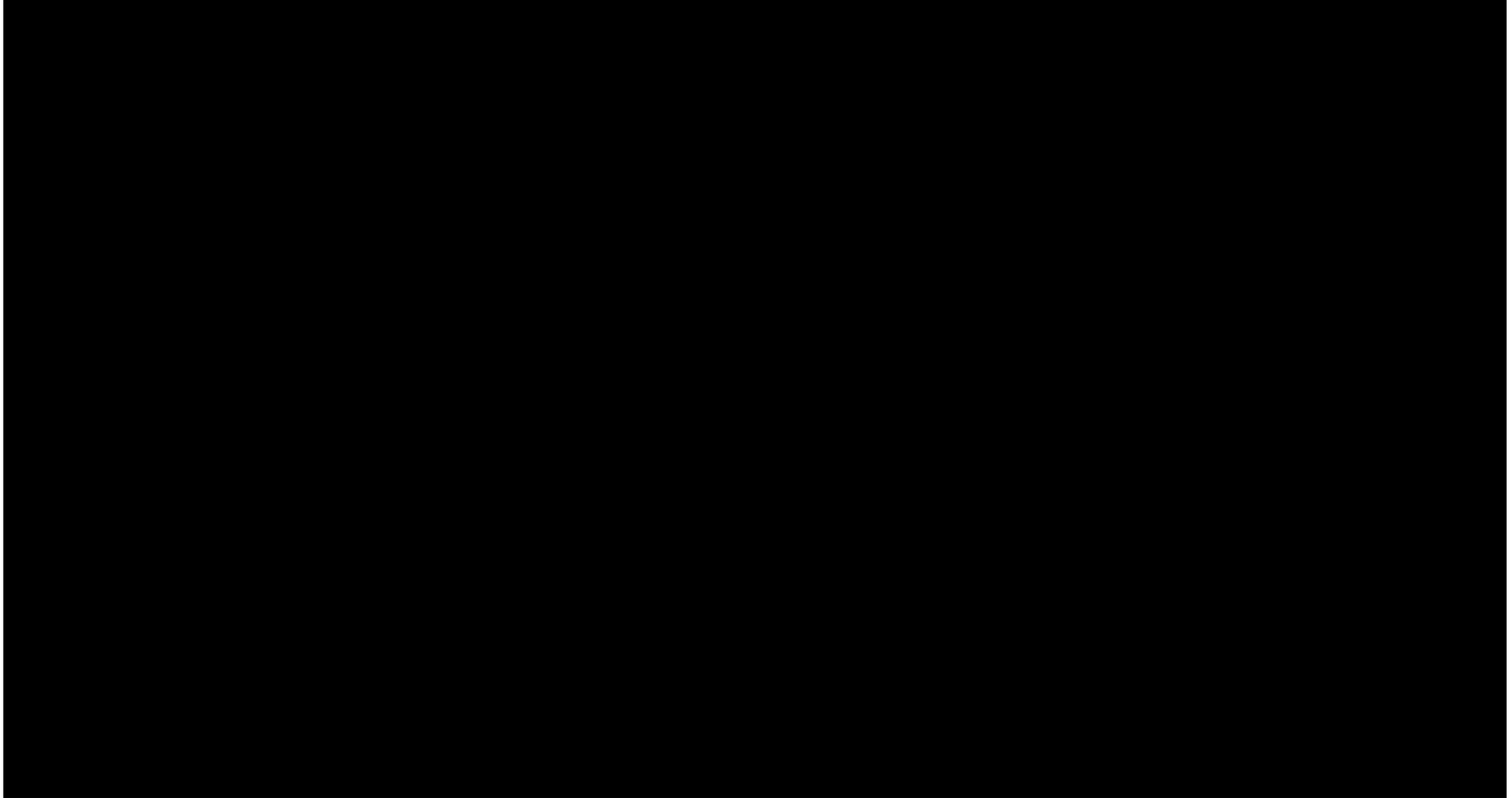
Texas A&M University has data on cities' traffic congestion going back to at least 1982. In 2017, the most recent year for which data is available, Seattle drivers spent an average of 78 hours sitting in traffic, a record for the city in this annual study.



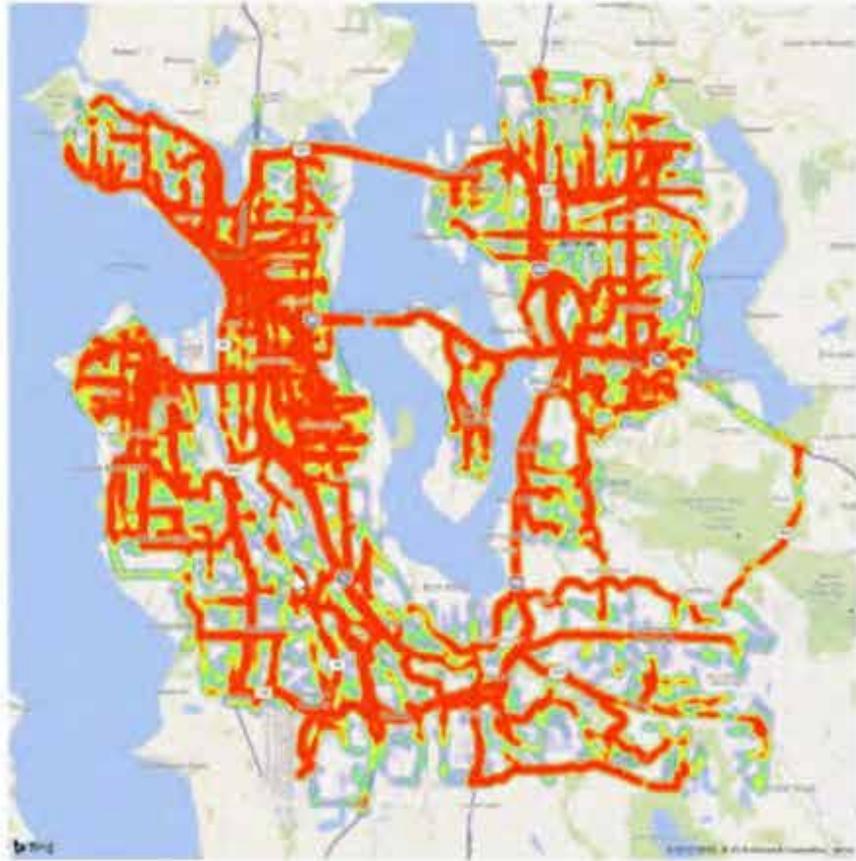
Source: Texas A&M University Urban Mobility Report

MARK NOWLIN / THE SEATTLE TIMES

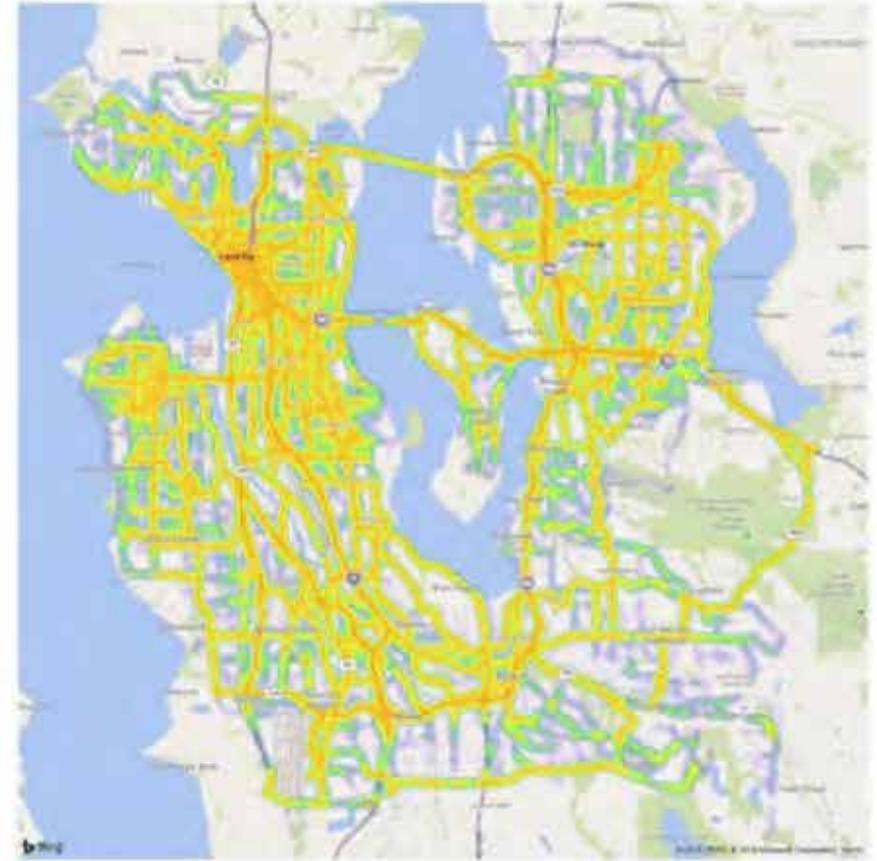
Adaptive Cruise Control for Traffic Jam Reduction



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 Wacker Place, Brooklyn NY 11221
718.768.3447
www.schaller7@gmail.com



TNCs & Congestion

DRAFT REPORT | OCTOBER 2016

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?

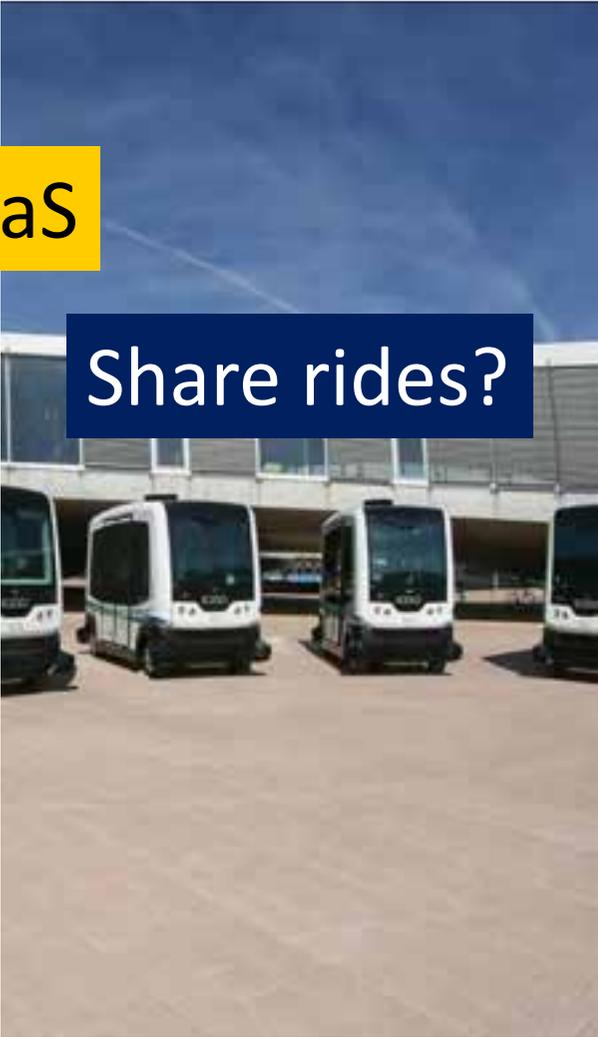
Market 1



Buy rides?

Market 2

MaaS



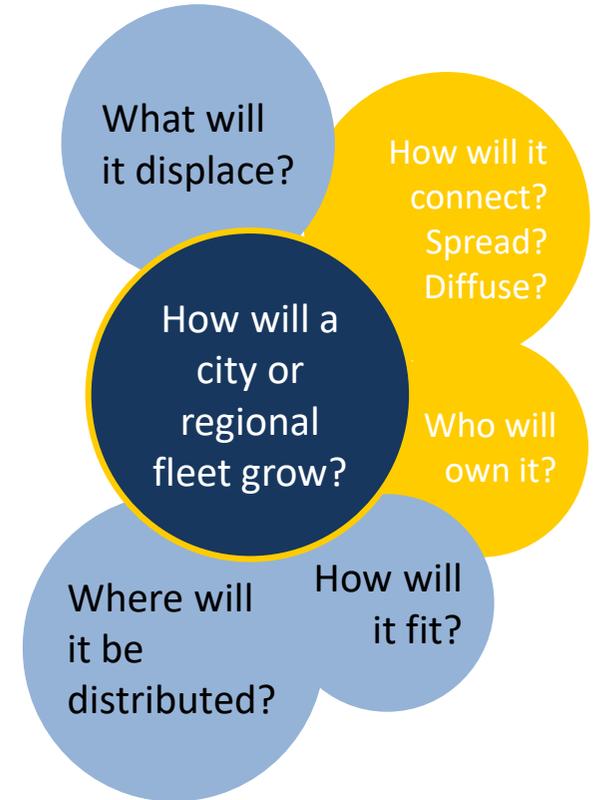
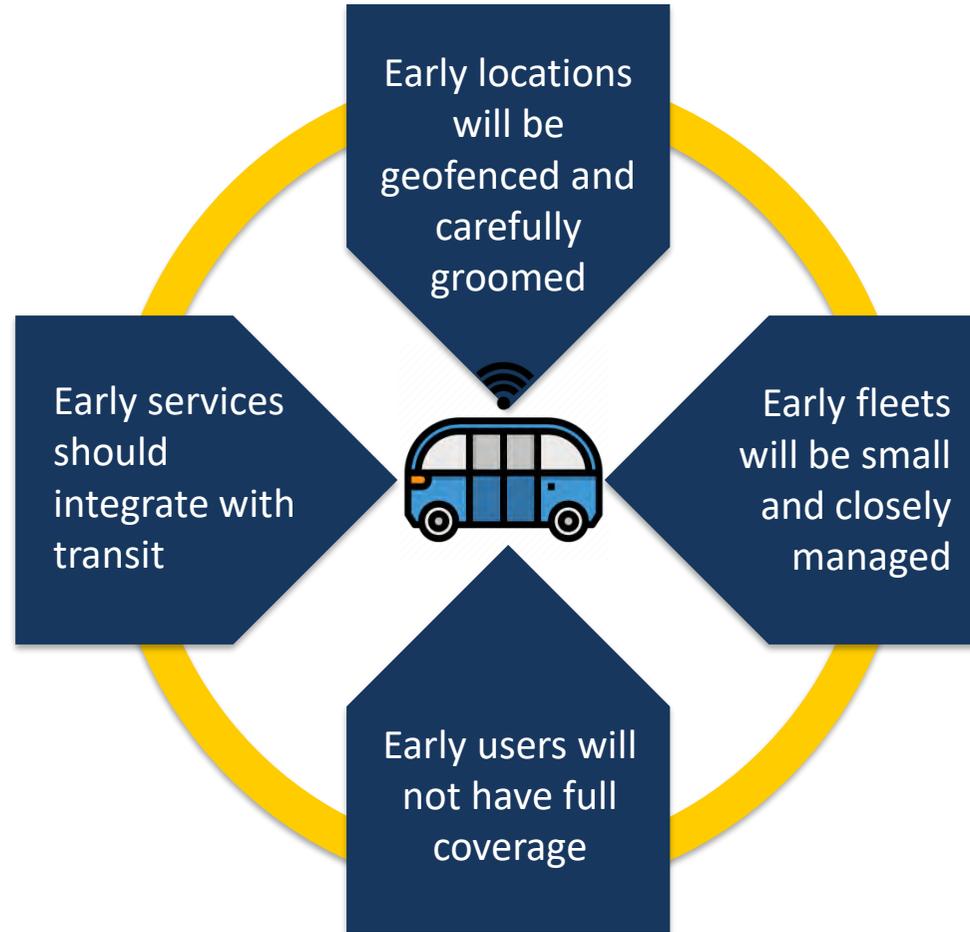
Share rides?



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?

Plan an **intentional evolution** toward large managed AV fleets



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 18th 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 18th 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

POLITICOMAGAZINE

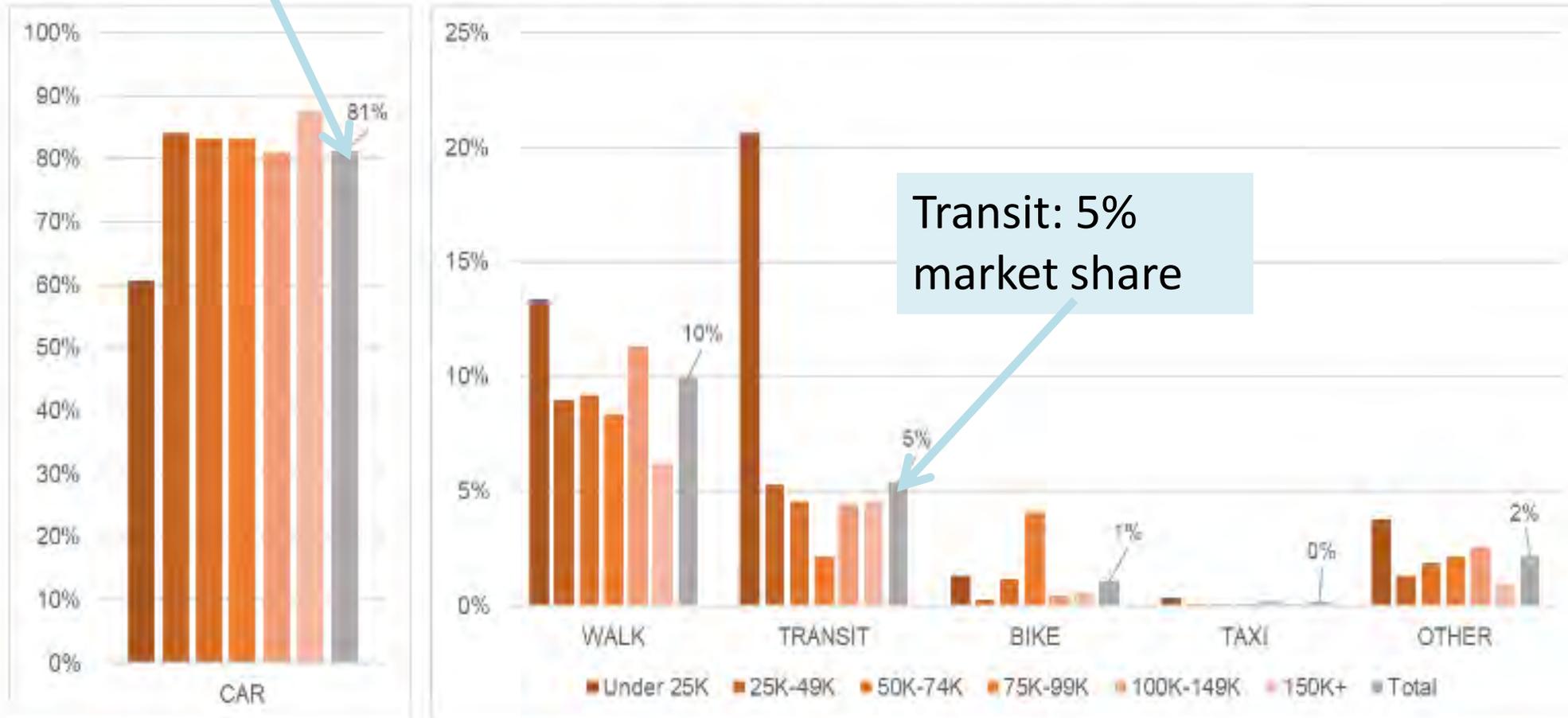


Mode shares in central Puget Sound region

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.

Origins and destinations are very dispersed in our modern urban region.

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

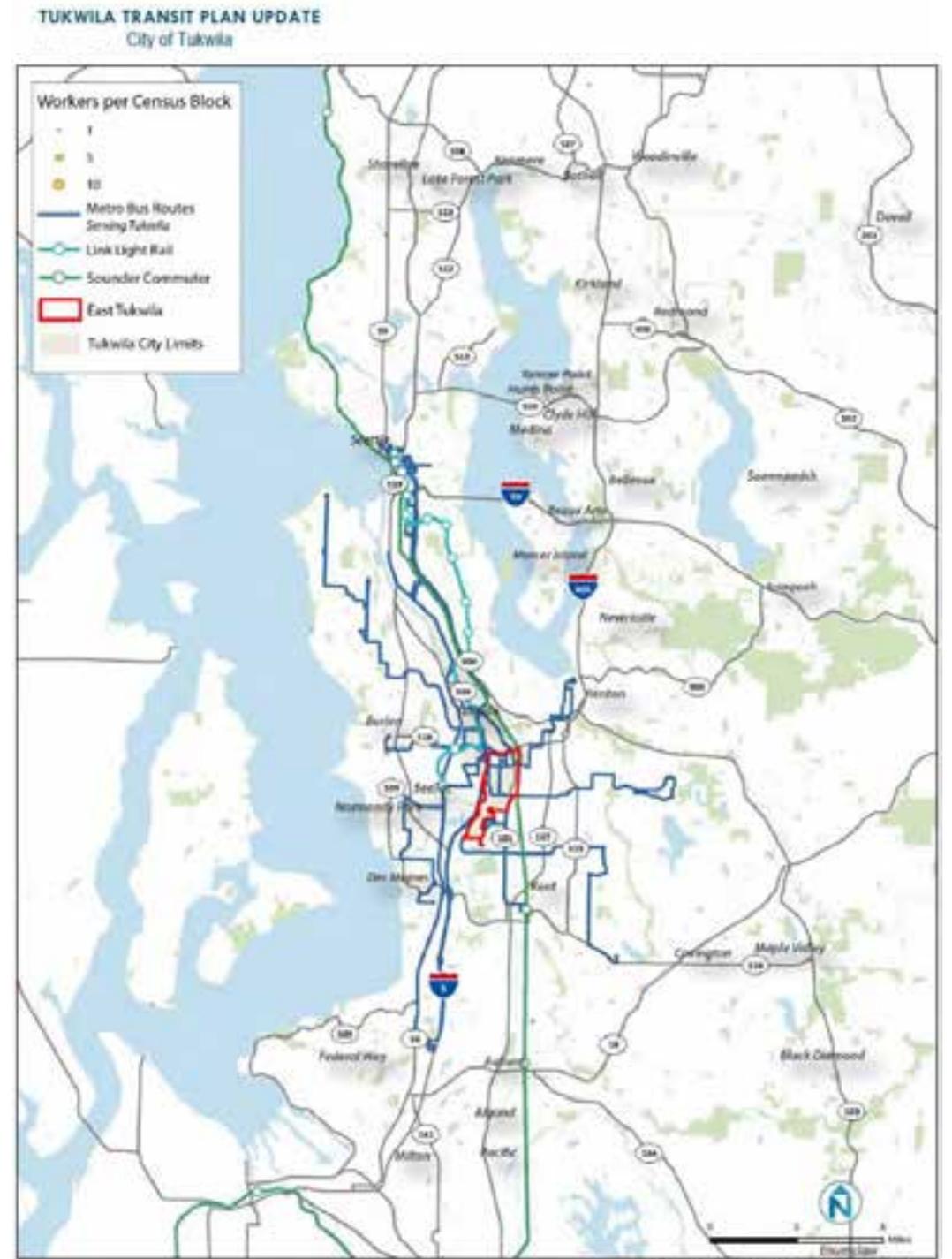
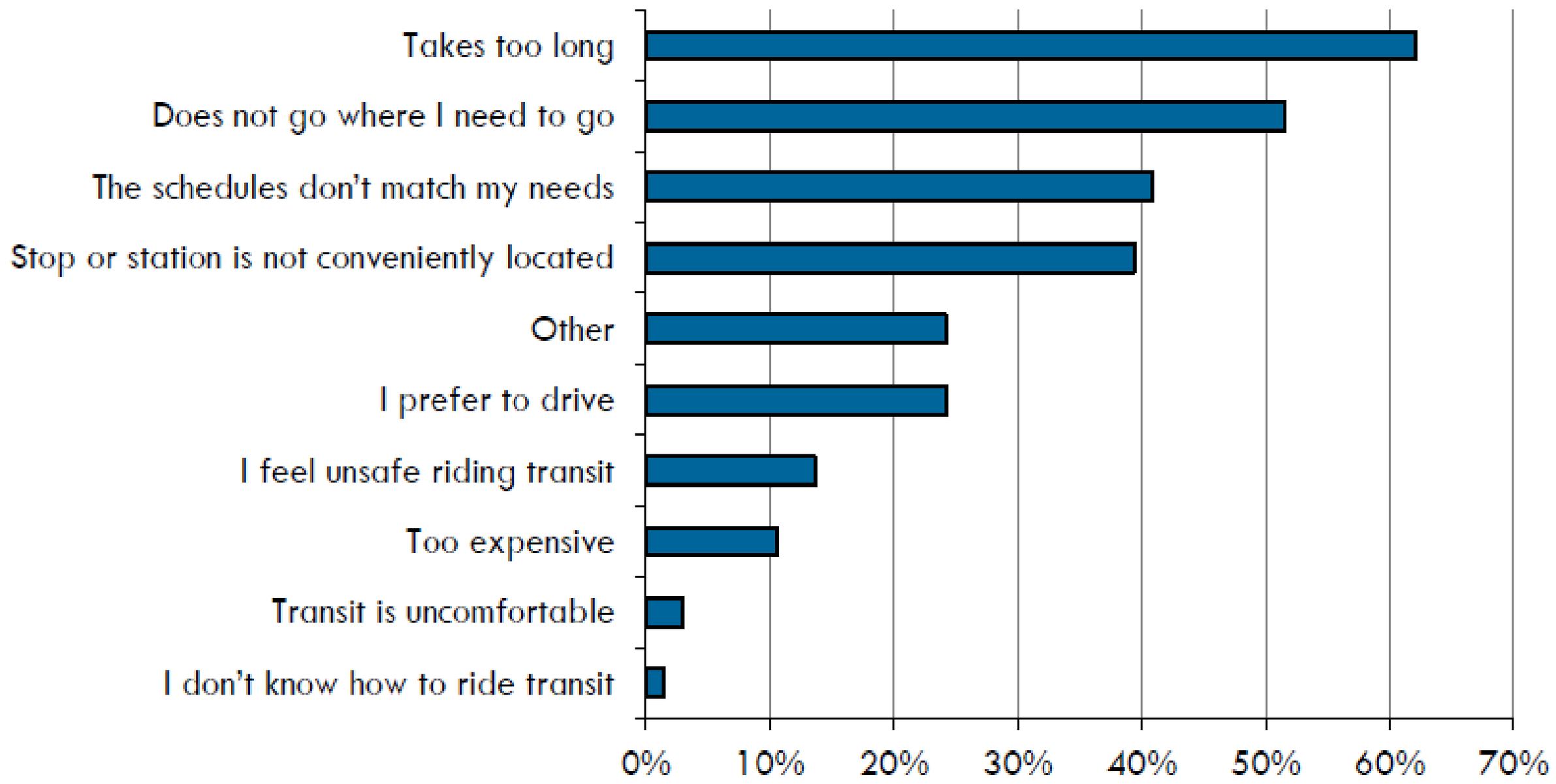
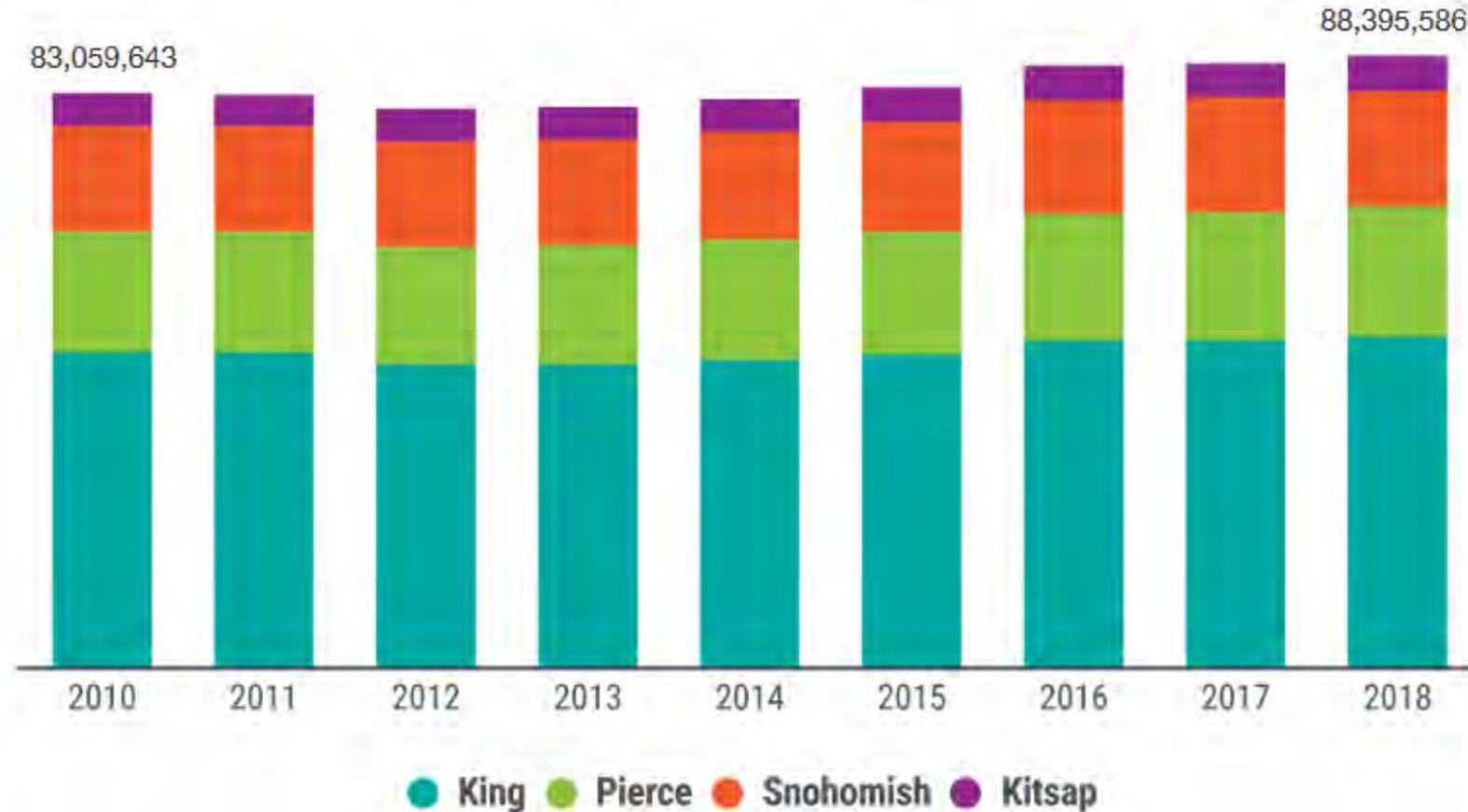


Figure 78 **Reasons why Respondents May Choose to Not Ride Transit (Multiple Responses Possible)**



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

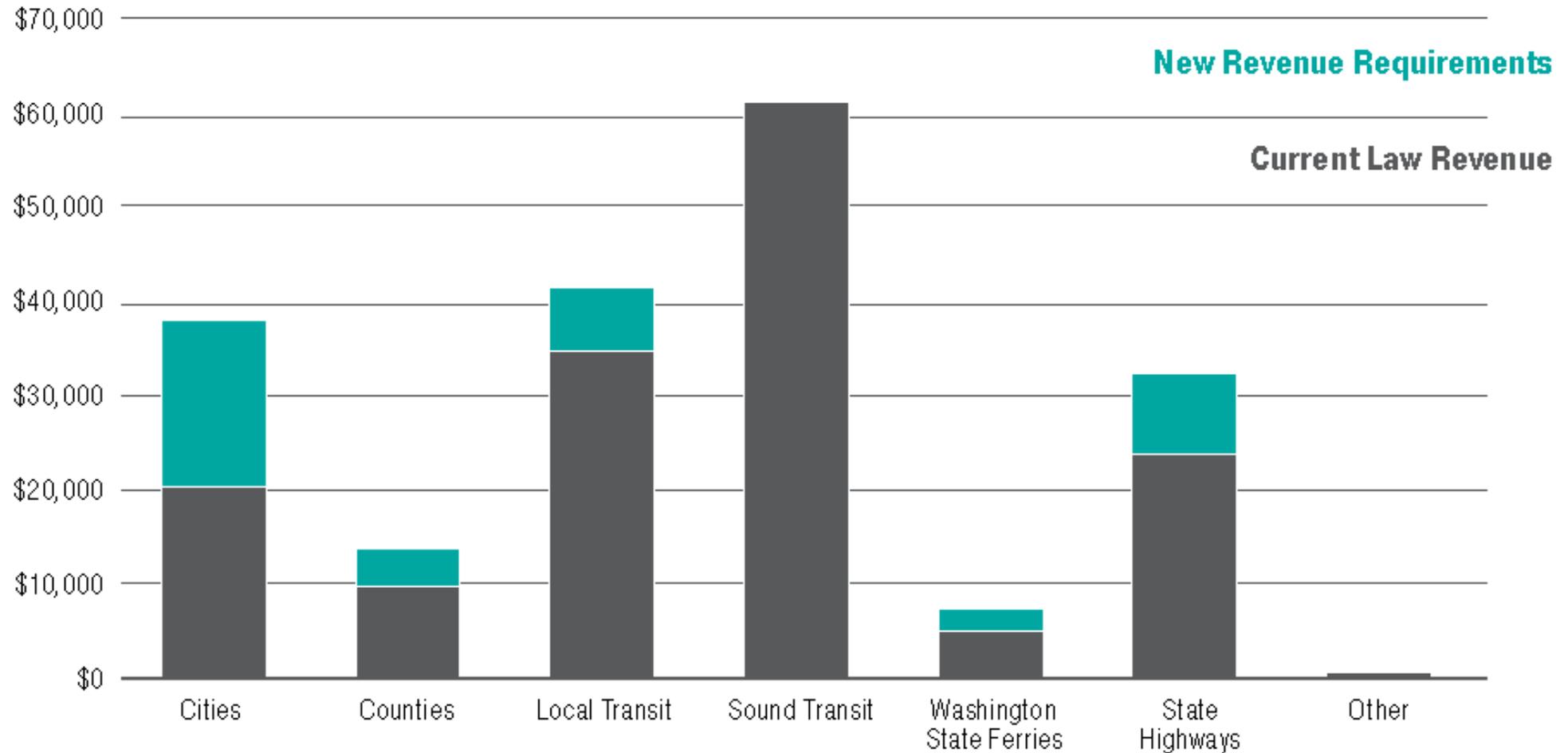
Exhibit 5
Travel Mode Shares

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.

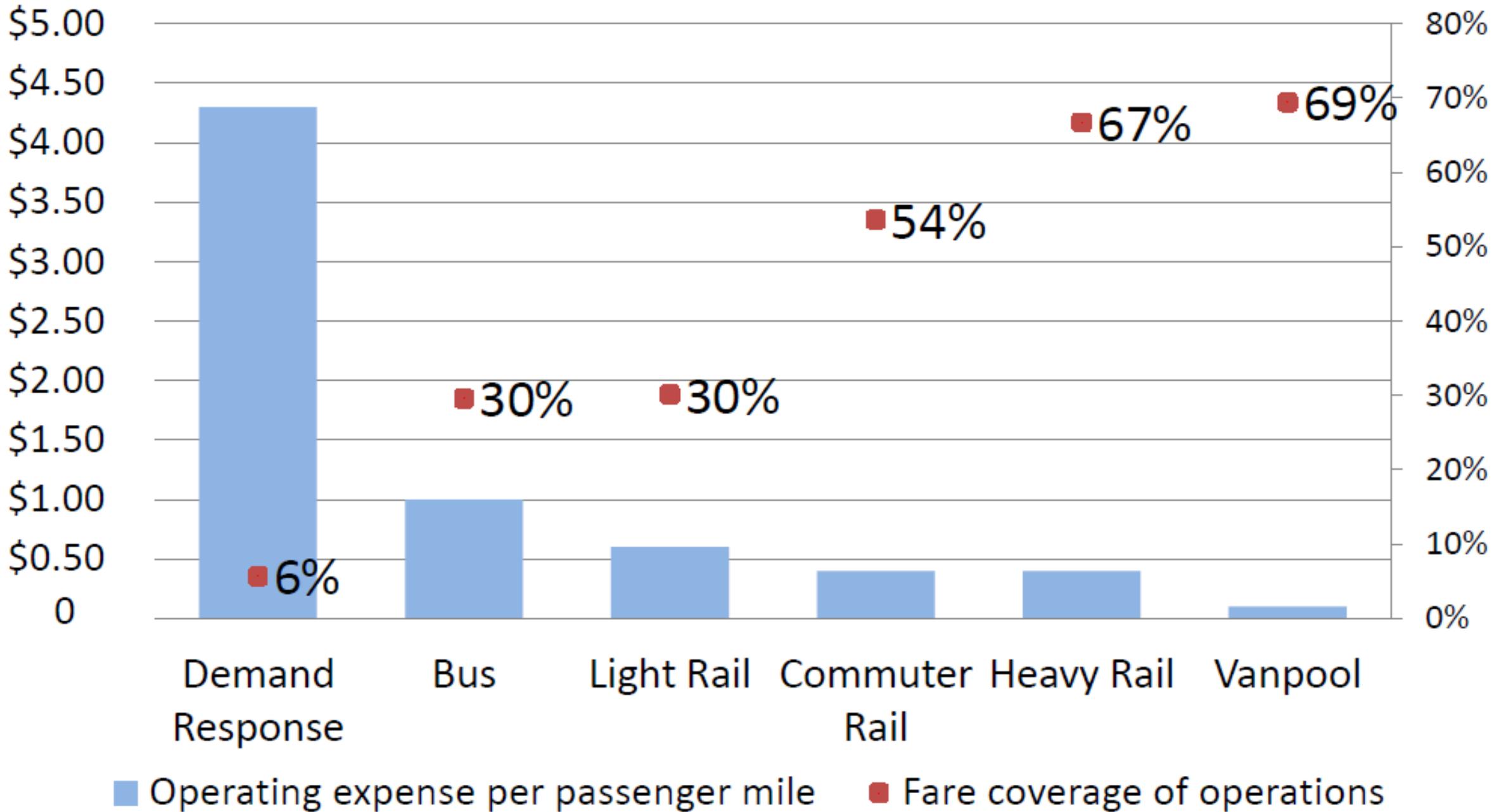
Cost of public transit creates need for efficiency in public transit expansion

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>

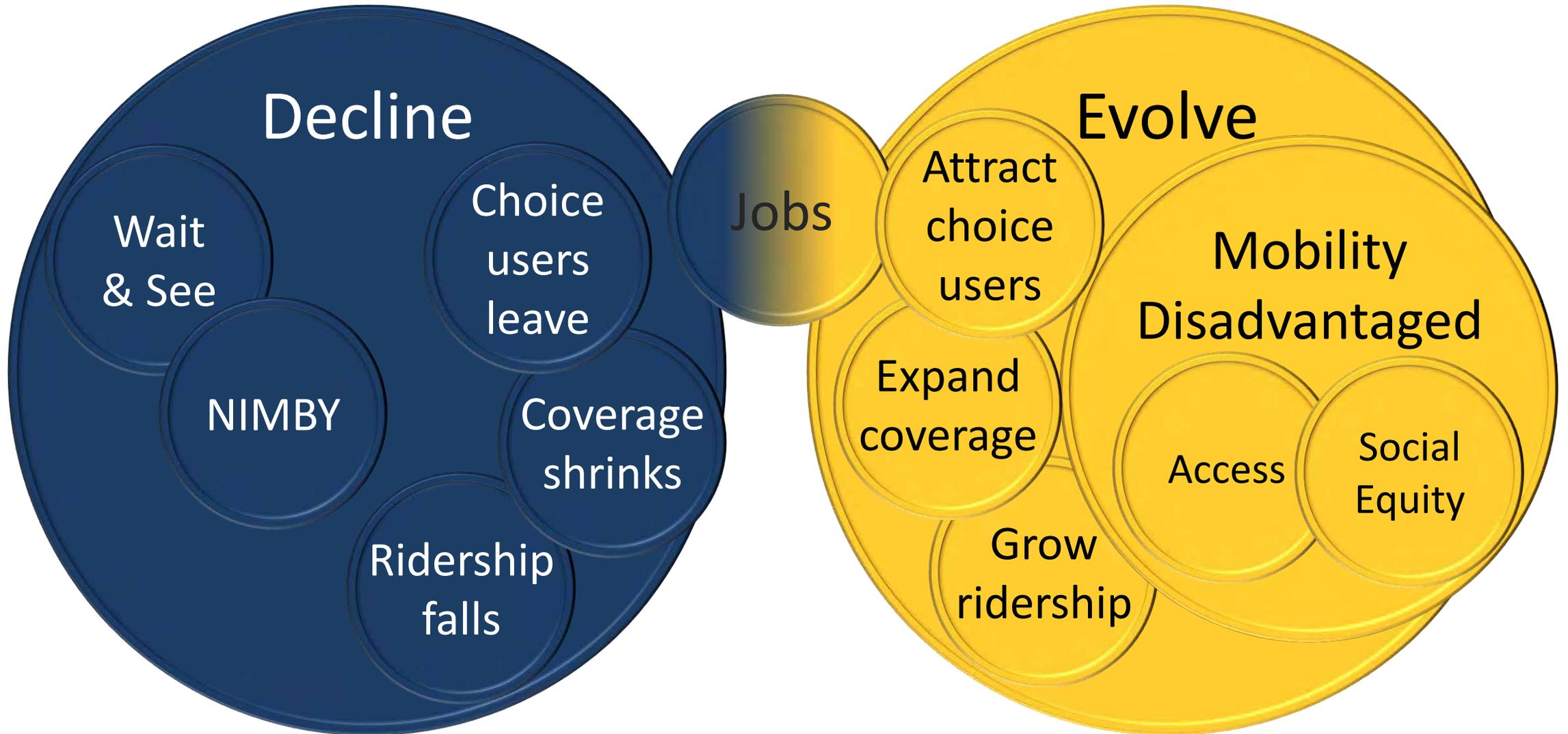
Effect of Driver Wages on Cost per Passenger Mile by Mode



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 18th 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 ↔ 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 18th 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

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 18th 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.

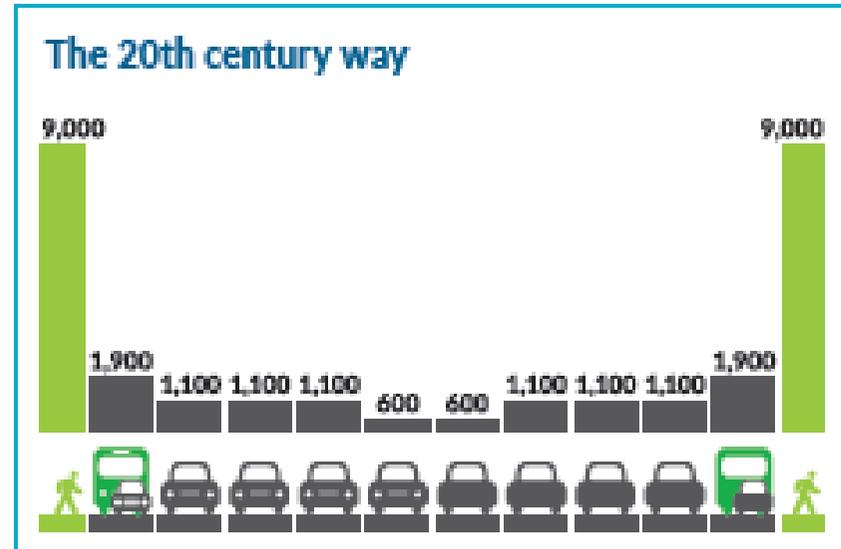
TRANSIT REDEFINED delivers UNIVERSAL BASIC MOBILITY

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

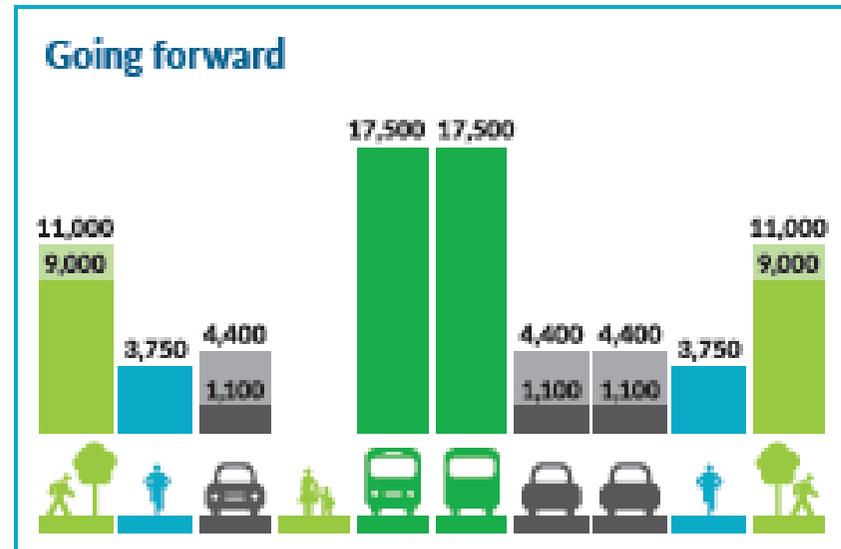
- **Public and government adopt these attitudes**
 - Understand mode split realities and small vehicle geographic reach
 - Larger vision of “public transit” to include small vehicle services
 - Support intermodalism: private, small vehicles ↔ heavy public transit
 - Support Universal Basic Mobility in 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 18th 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?



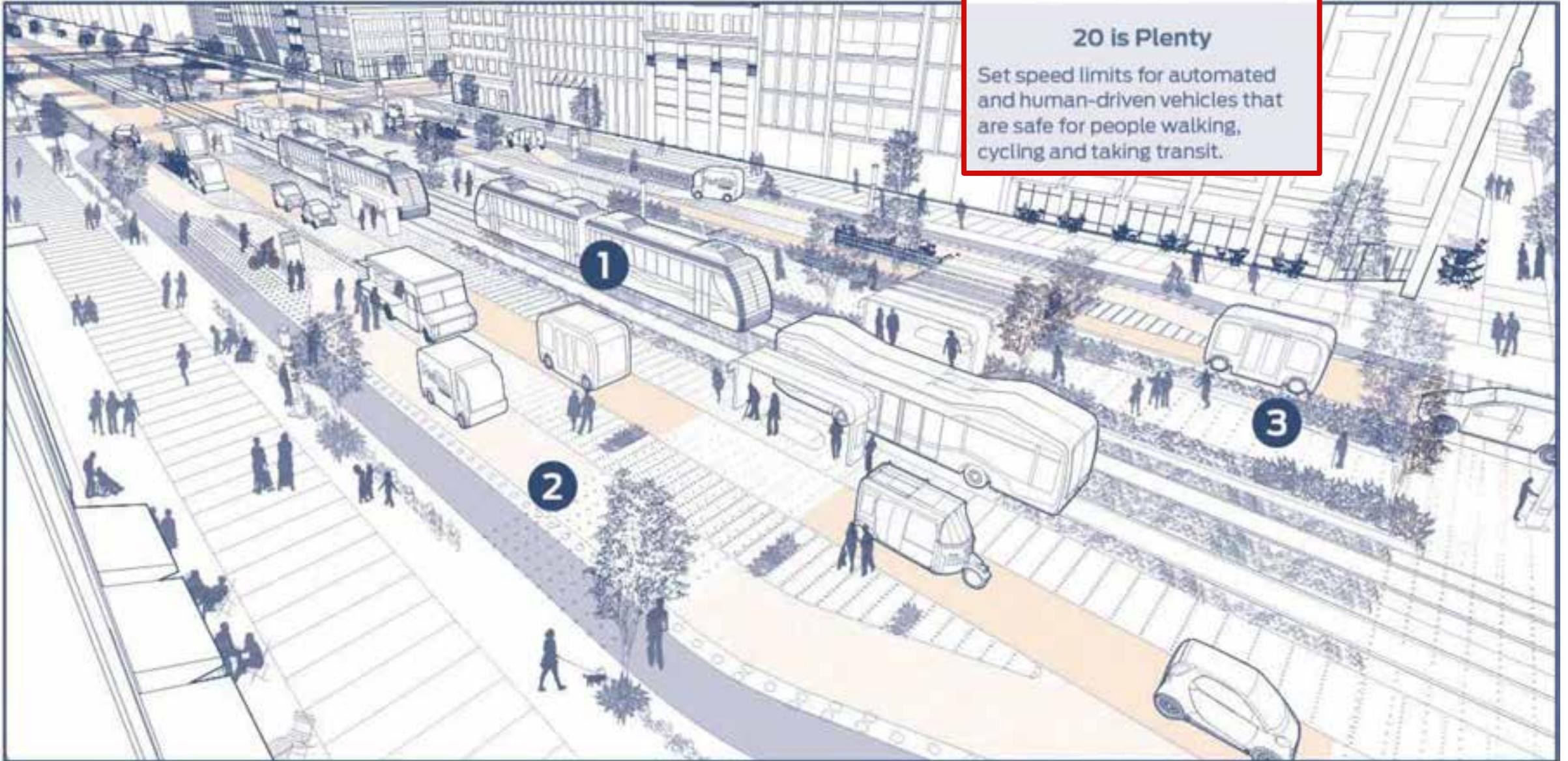
This seems an unusually specialized street

- 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. / Thibault Camus/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



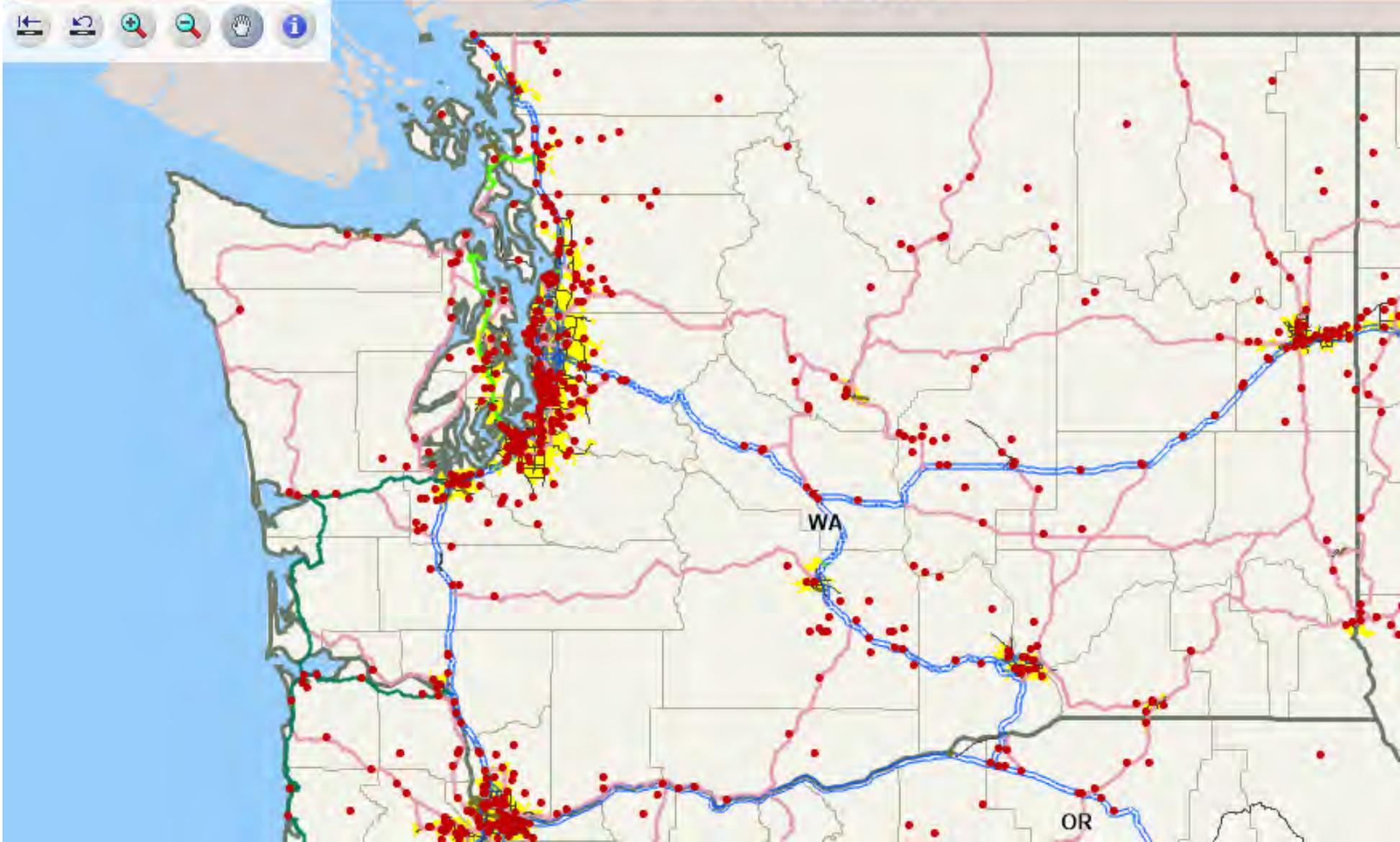
BROOKS RAINWATER

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 18th 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?

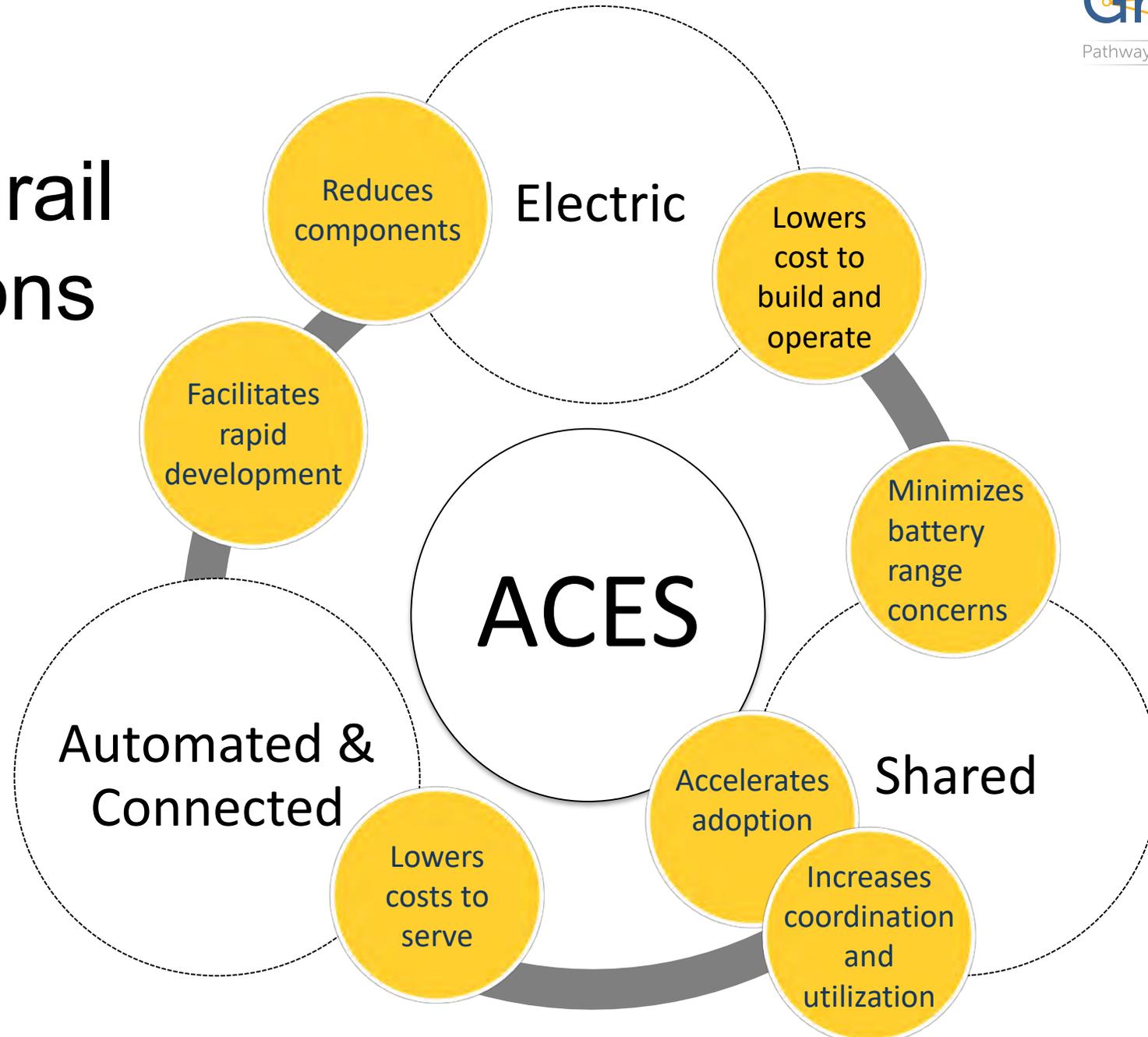
Point of Comparison:

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 18th 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

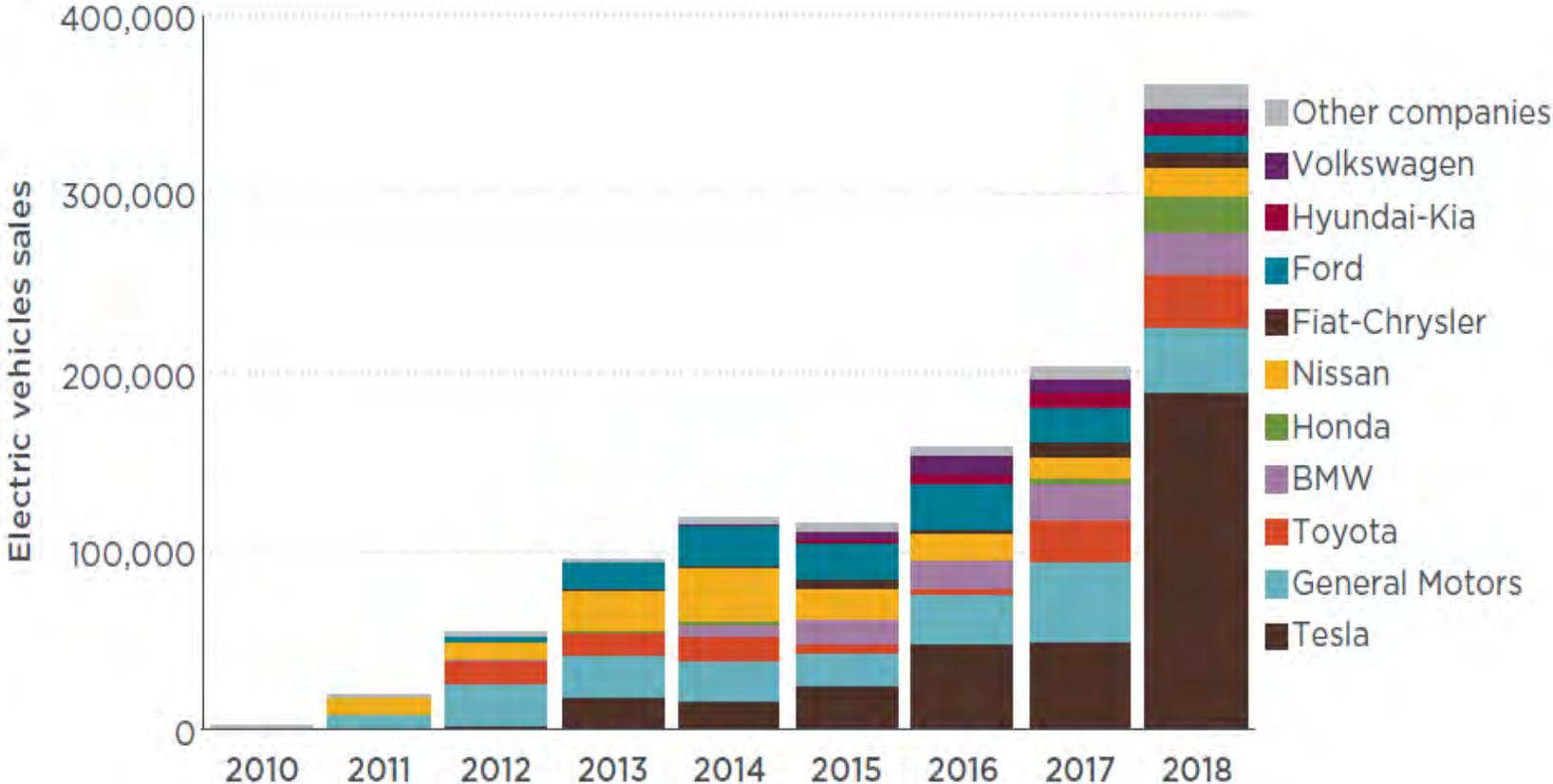


Figure 1. Automaker electric vehicle sales in the United States through 2018. (Vehicle sales data from EV-volumes, 2019)



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.

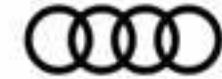
Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **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 18th 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 sign recognition
- Stop&Go incl. Traffic jam assist
- Audi active lane assist
- 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 assist

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

HLDI and IHS 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 ↔ 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 18th 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

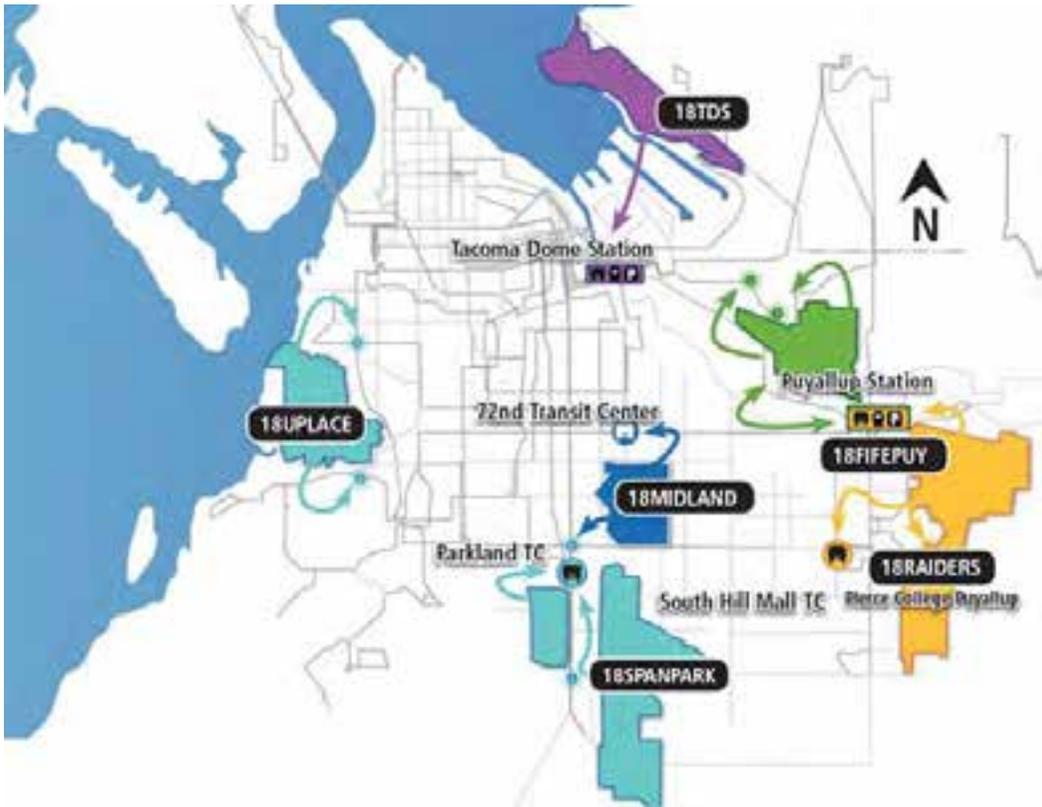
Pierce County example
of transit coverage

Bus network has limited
geographic reach

Frequency and time of
day service also limited



Example: Pierce Transit and Lyft



LIMITED ACCESS CONNECTIONS

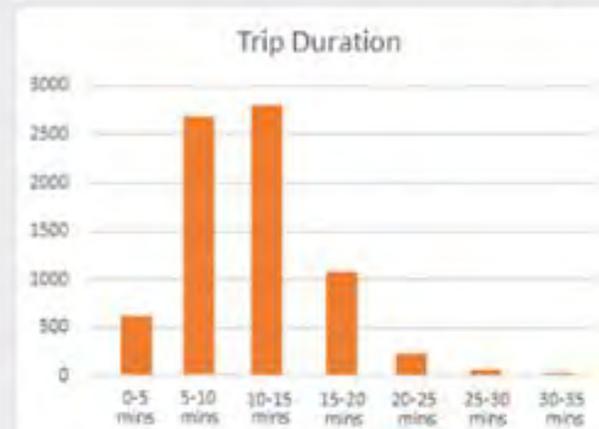
PILOT PROGRAM ENDS DECEMBER 31, 2019

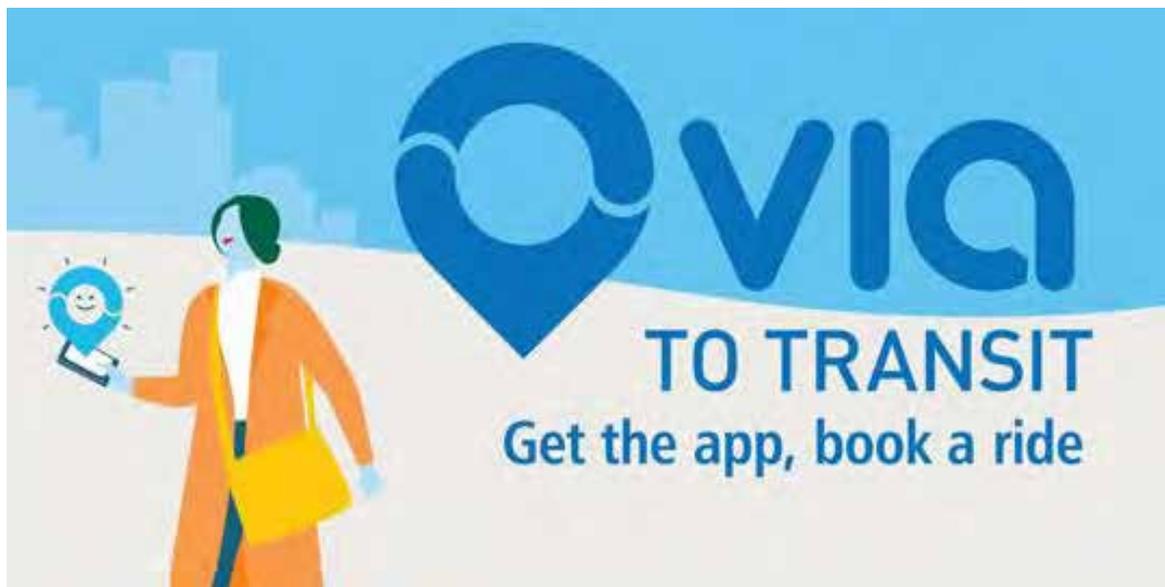


Providing first and last mile service connections for transit users

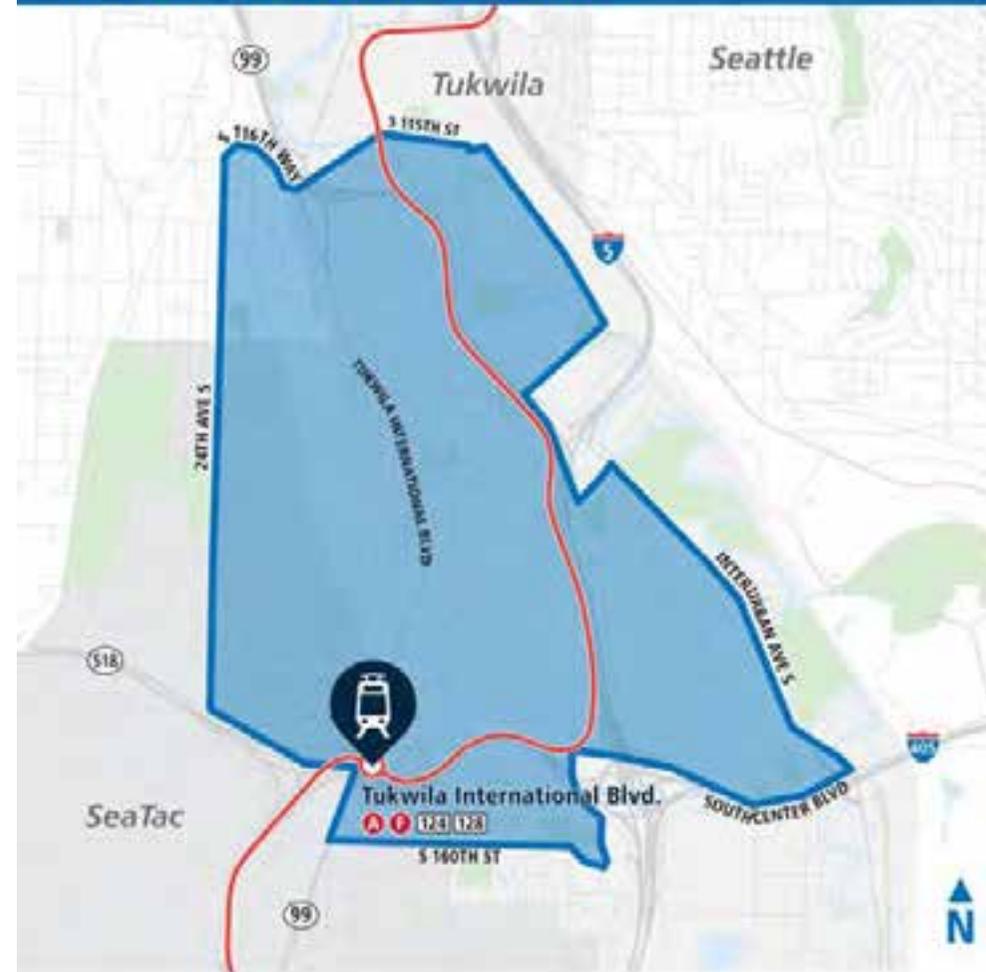


During this project, Pierce Transit learned a lot about first & last mile service in partnership with Lyft. Here are some of the results.





VIA TO TRANSIT – Tukwila Service Area
Monday–Friday: 6–9 a.m., 3:30–6:30 p.m.



LEGEND

- Tukwila International Blvd. Station service area
- Bus connections
- Link light rail
- Link light rail station

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

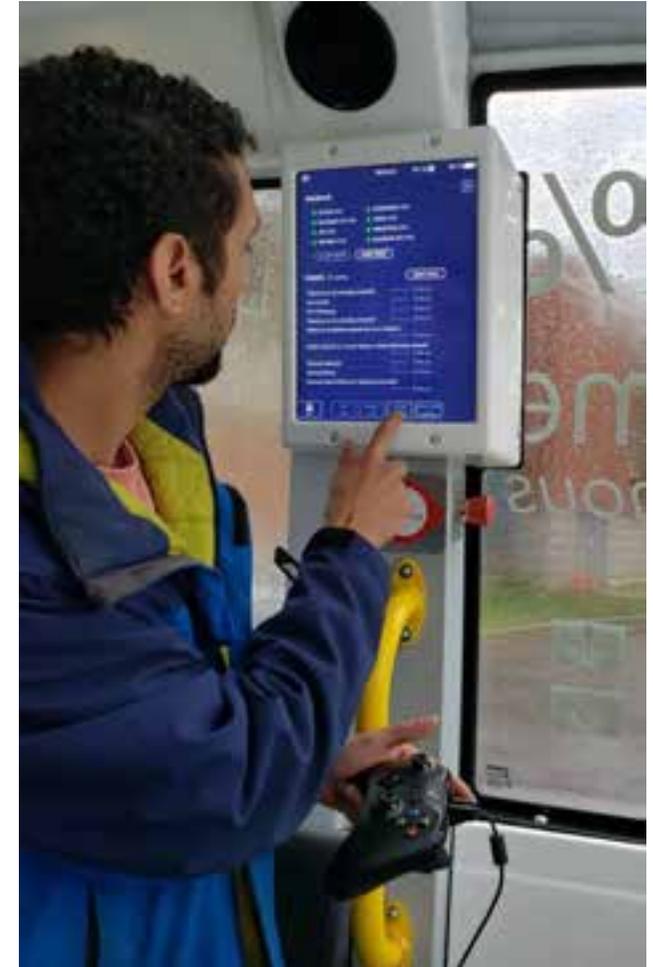


City of SeaTac and neighboring Tukwila and Burien have residential environments practical for safe operation of low-speed, first generation automated micro-transit

- 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

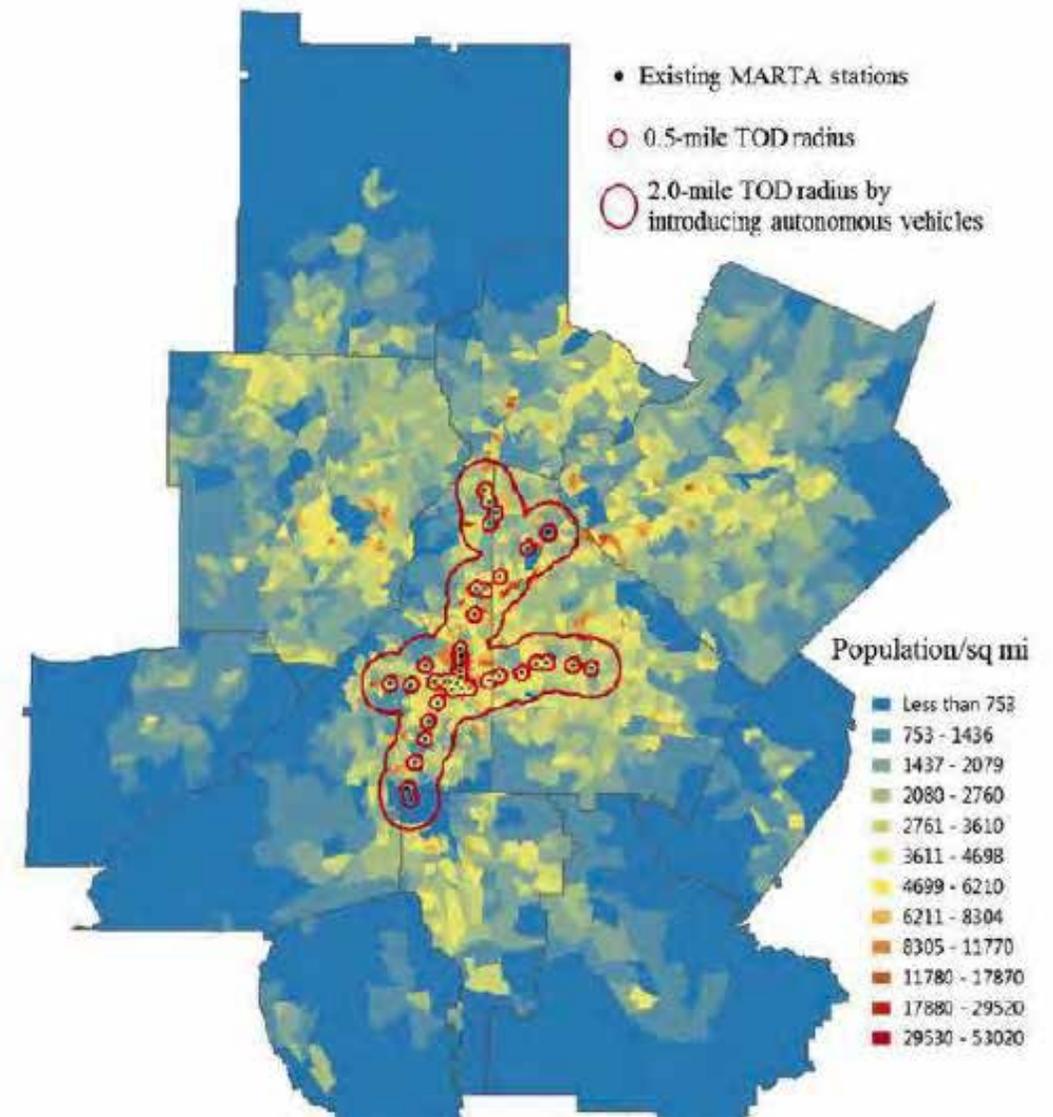


EV Shuttles So Far Have Skilled, Licensed Operators



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

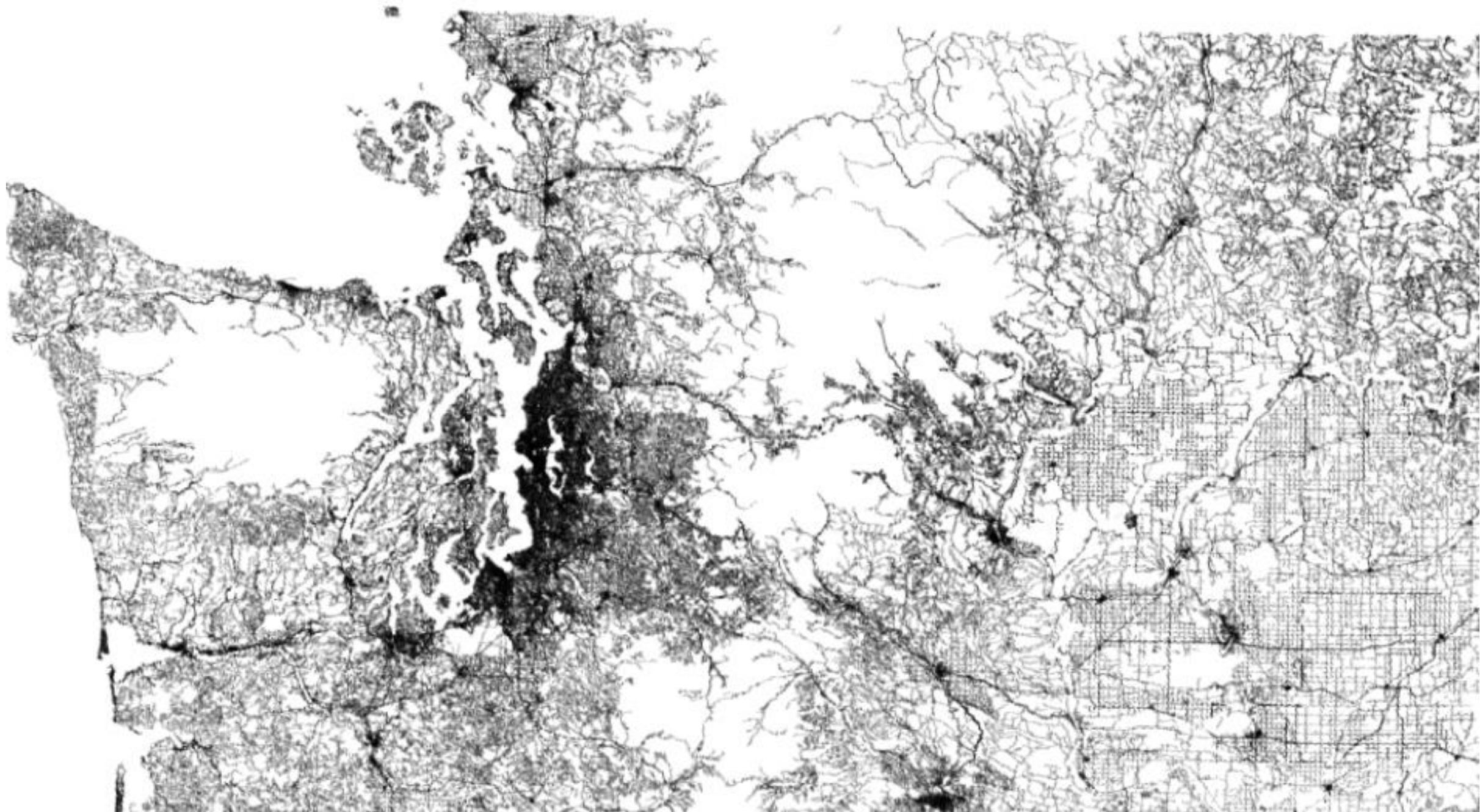
- Increase TOD radius from ½ mile to two miles
- Bring any resident to a transit hub using on-demand shuttles in same time as needed for a 10 minute walk.
- Increase TOD area of access to transit 16 fold



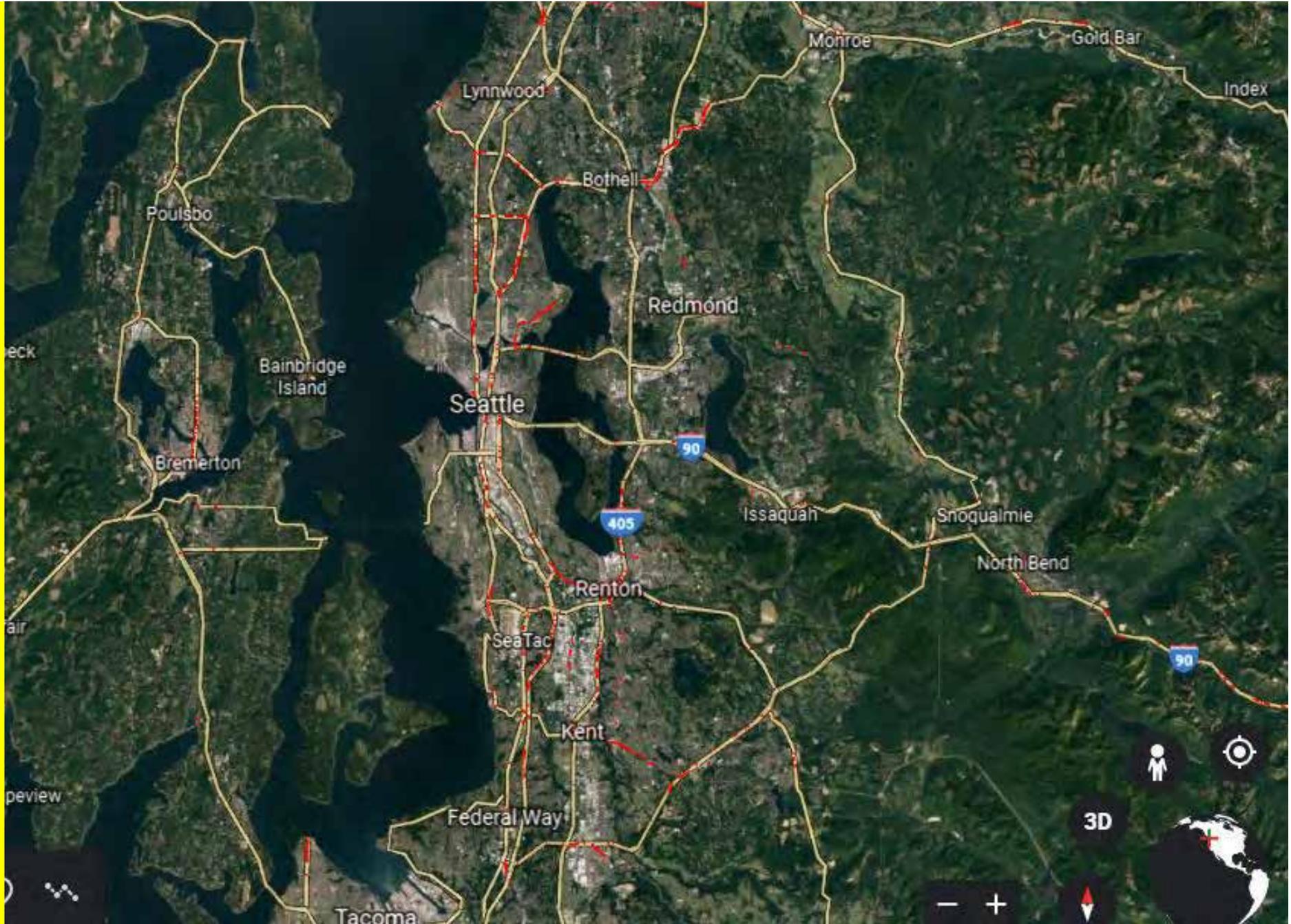
Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **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 18th 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 ↔ 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 18th 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

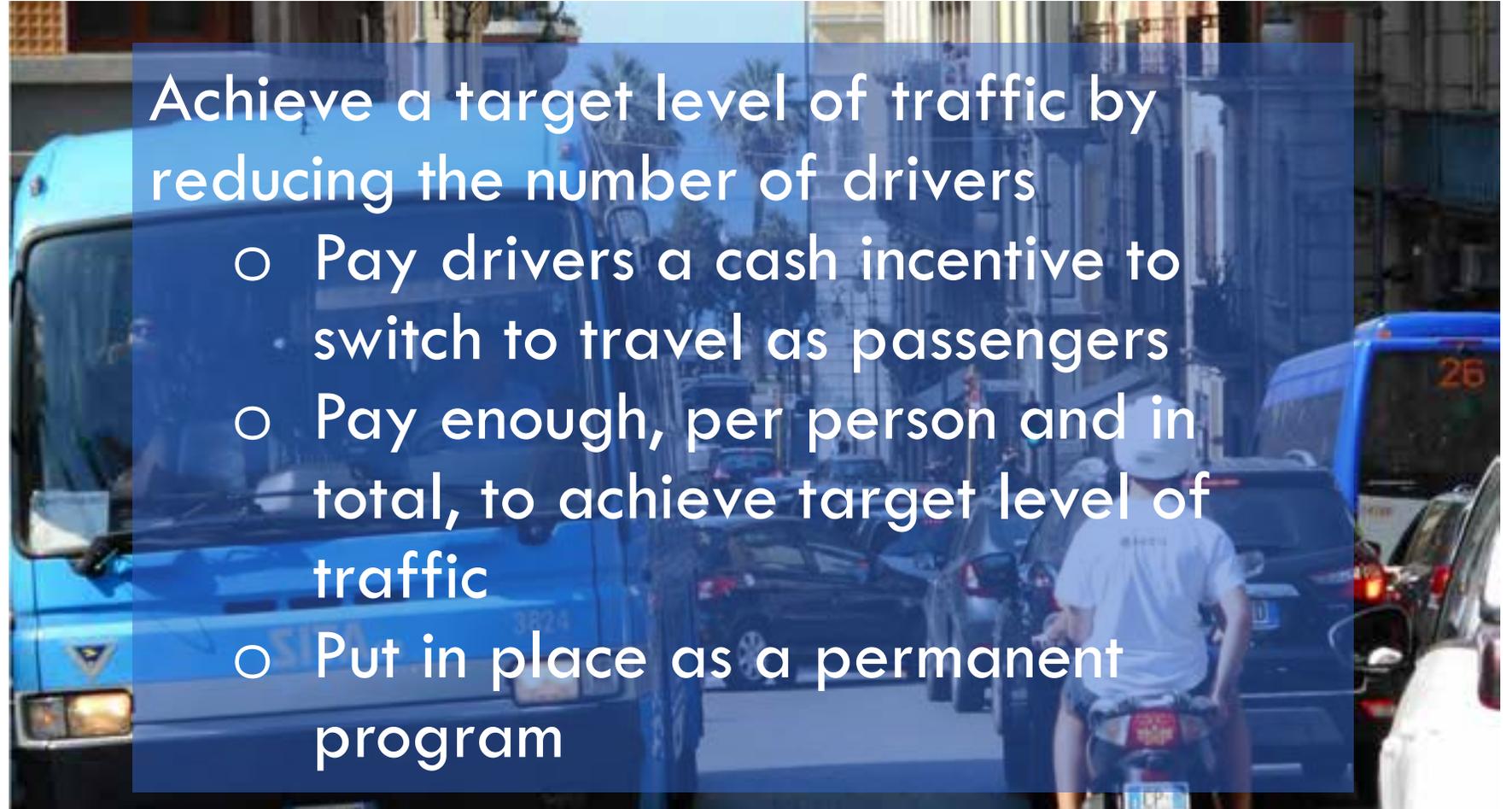


Steps to shift private vehicle travel to automated common carrier ride-hail vehicles

- **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 18th 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

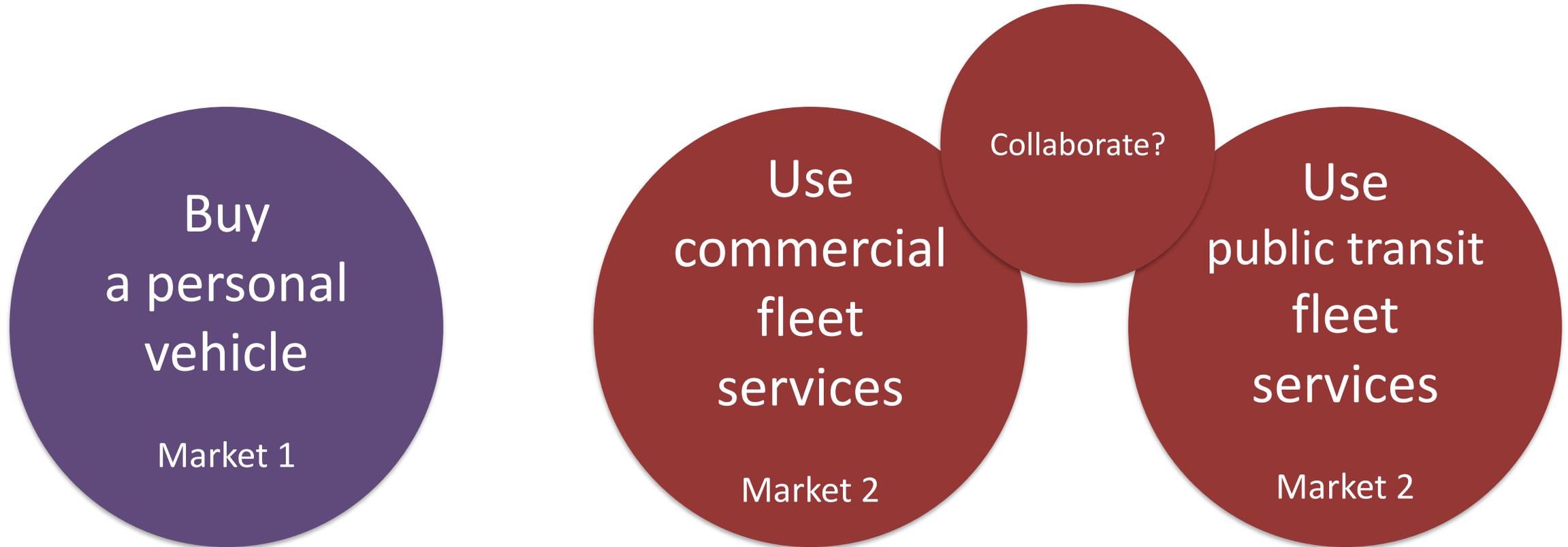
Title: “Congestion Clearing
Payments to Passengers”
Research Project 1817
Funded by Mineta
Transportation Institute at
San Jose State University,
2018-19
Paul Minett, Principal
Investigator



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 18th 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)

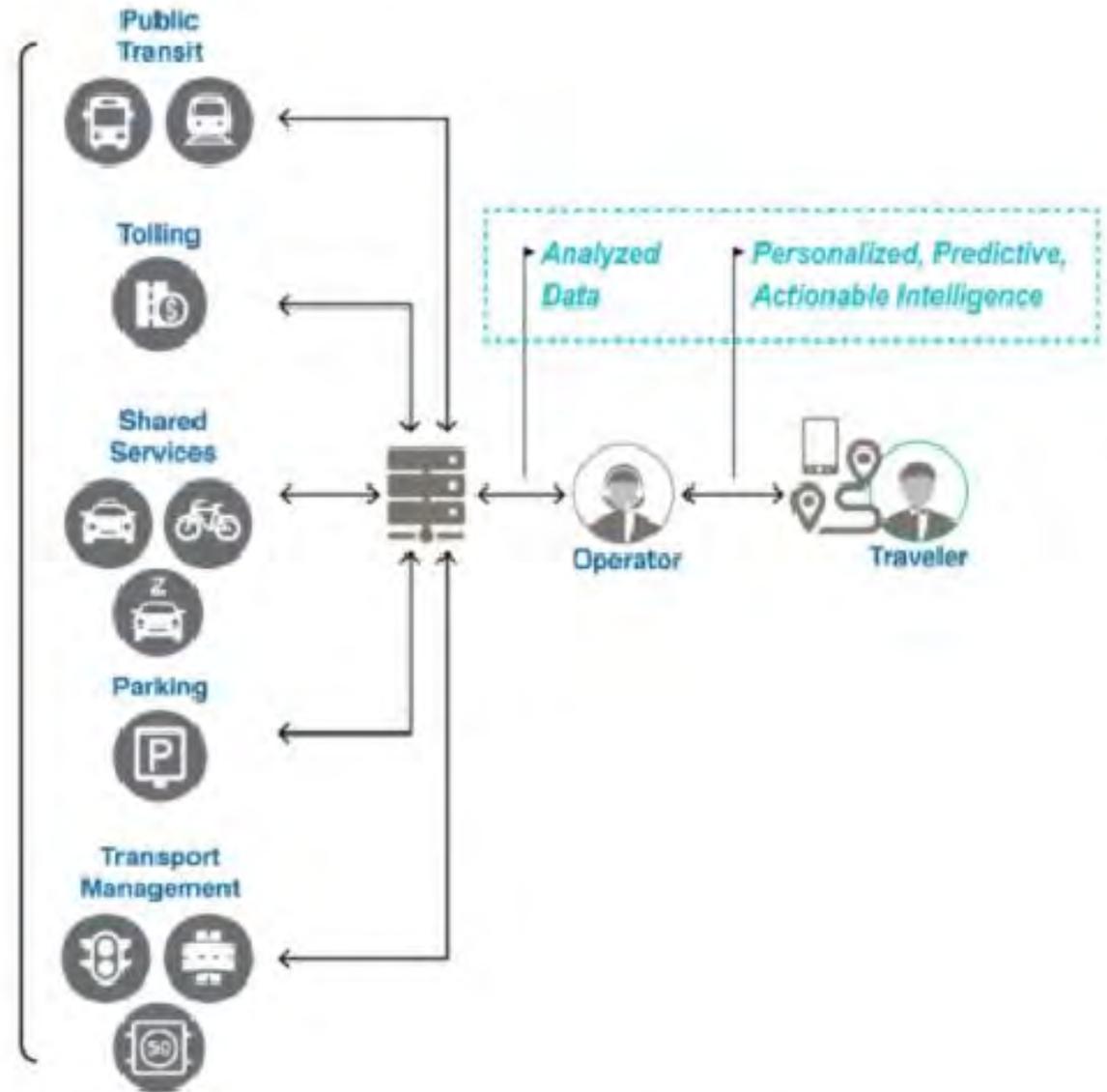
MaaS = Mobility as a Service

MOD = Mobility on Demand

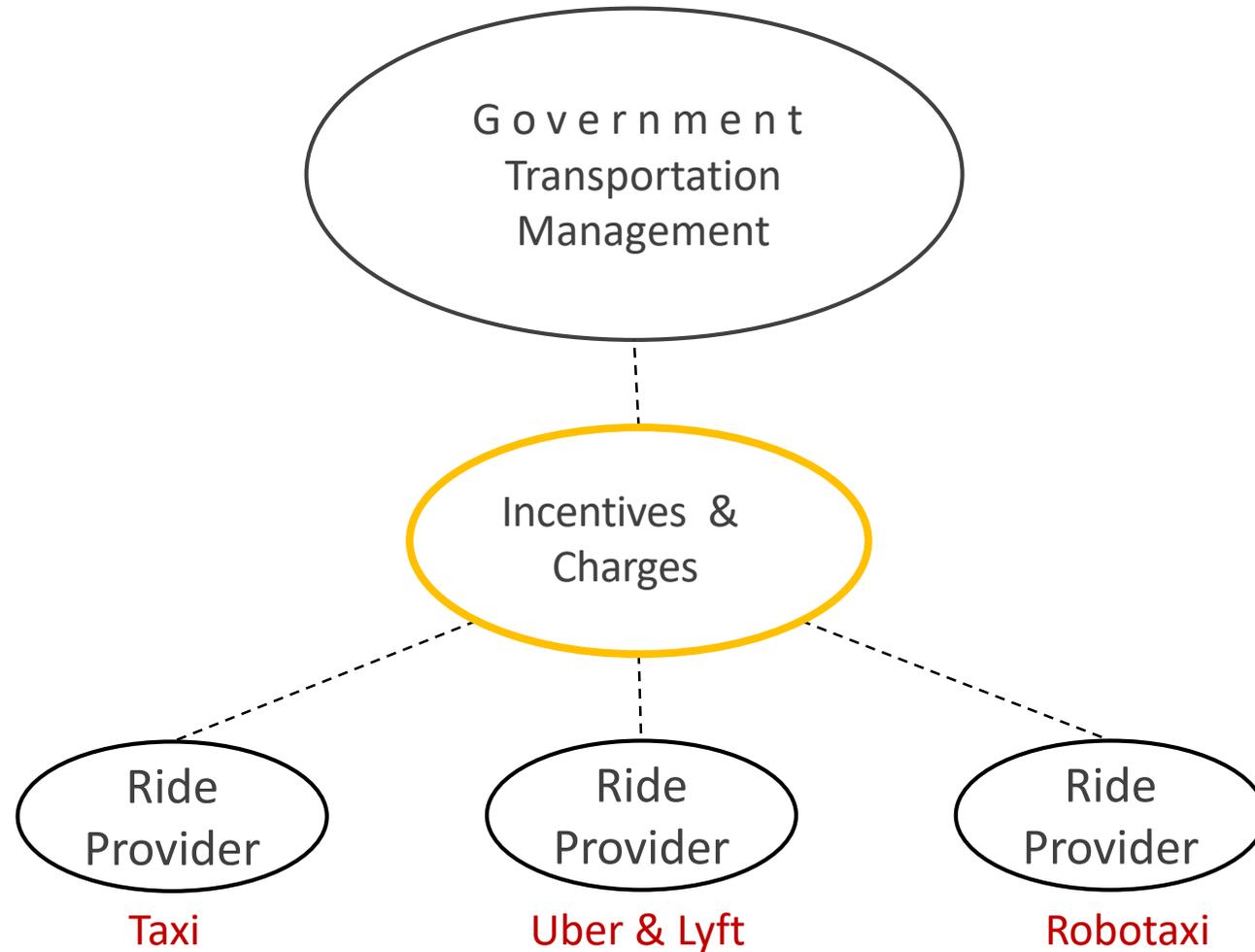
Formerly: Dial-a-Ride

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**

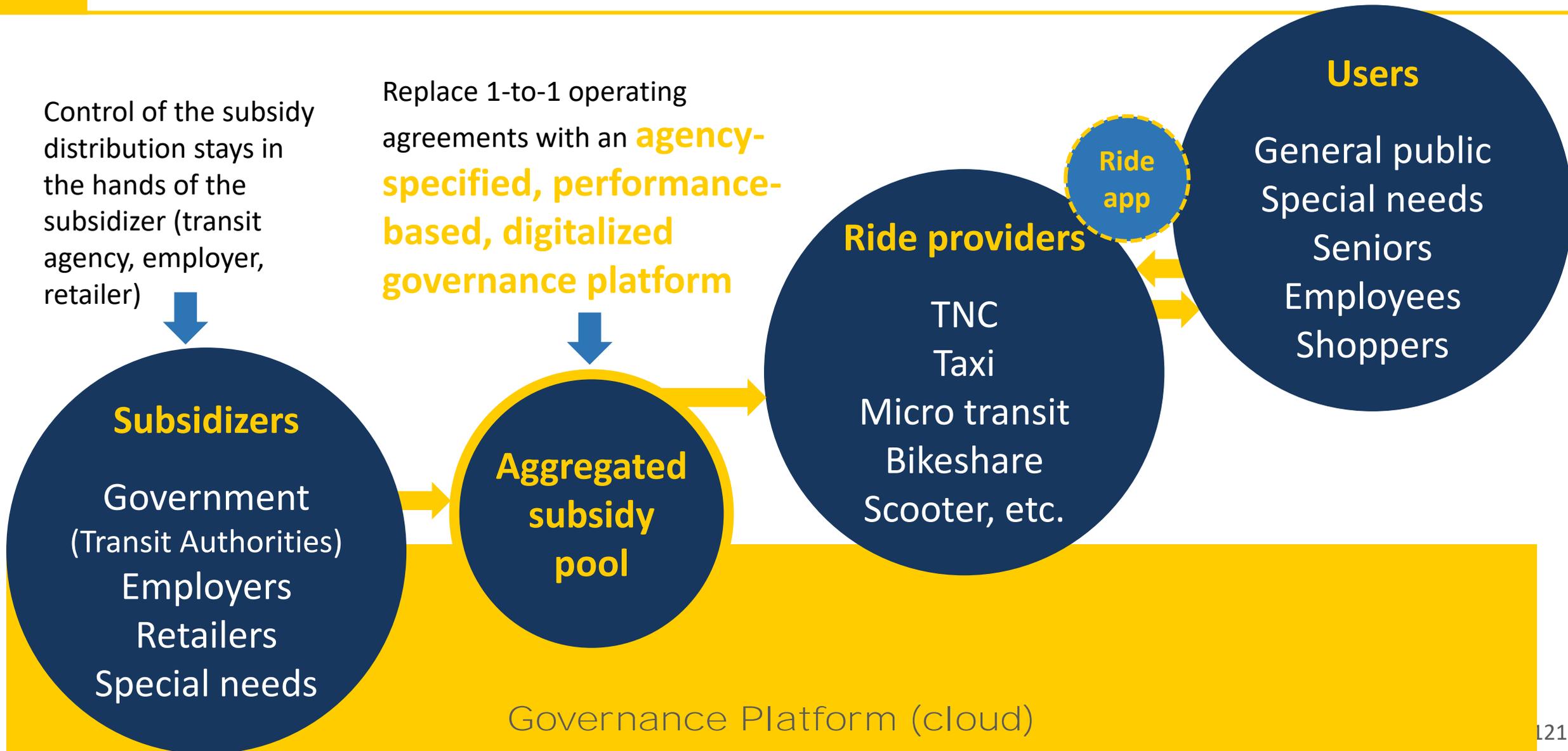
Tomorrow

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

Transit-provider partnership

Control of the subsidy distribution stays in the hands of the subsidizer (transit agency, employer, retailer)

Replace 1-to-1 operating agreements with an **agency-specified, performance-based, digitalized governance platform**



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 18th 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

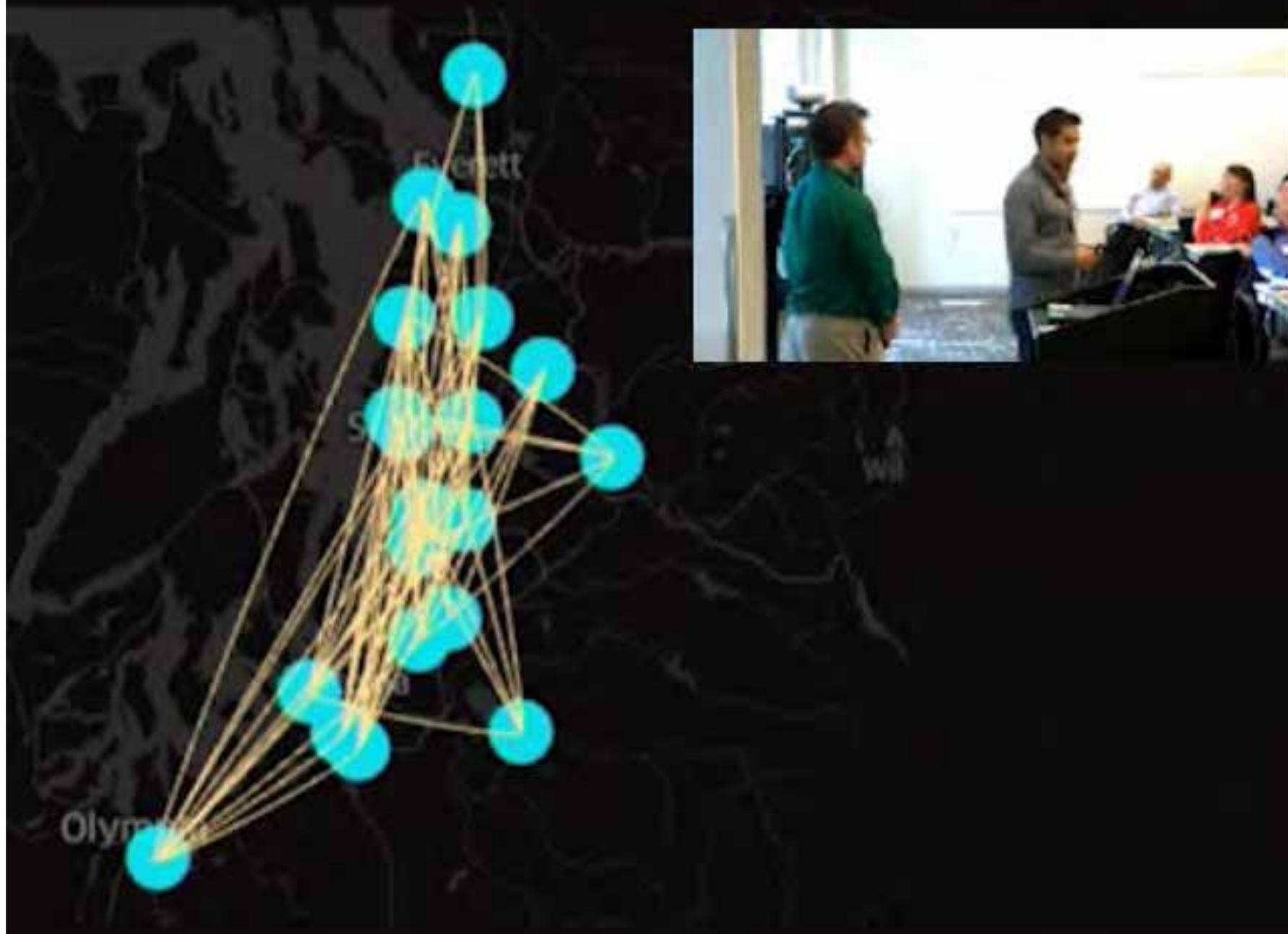
Robotic Flying Cars, Buses, & Freighters: Technically Easier Than Robotic Cars, Buses, & Trucks on Roads

NON-EXHAUSTIVE



VTOL Network in Seattle

**Uber Elevate
presentation
in Seattle,
2017**



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



Urban Air Mobility in the Puget Sound Region

November 2019

Port of Seattle



Gannett Fleming Skyport

1. Transportation grid in our region is becoming

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

“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 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 18th 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