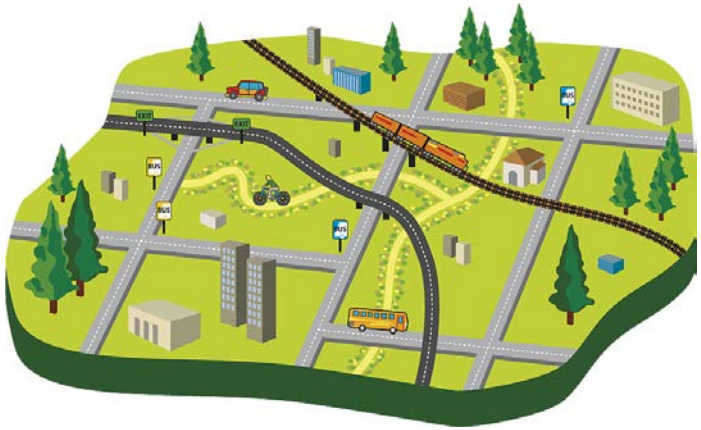
Automation & Sharing: Transforming Land Use, Transportation and Safety



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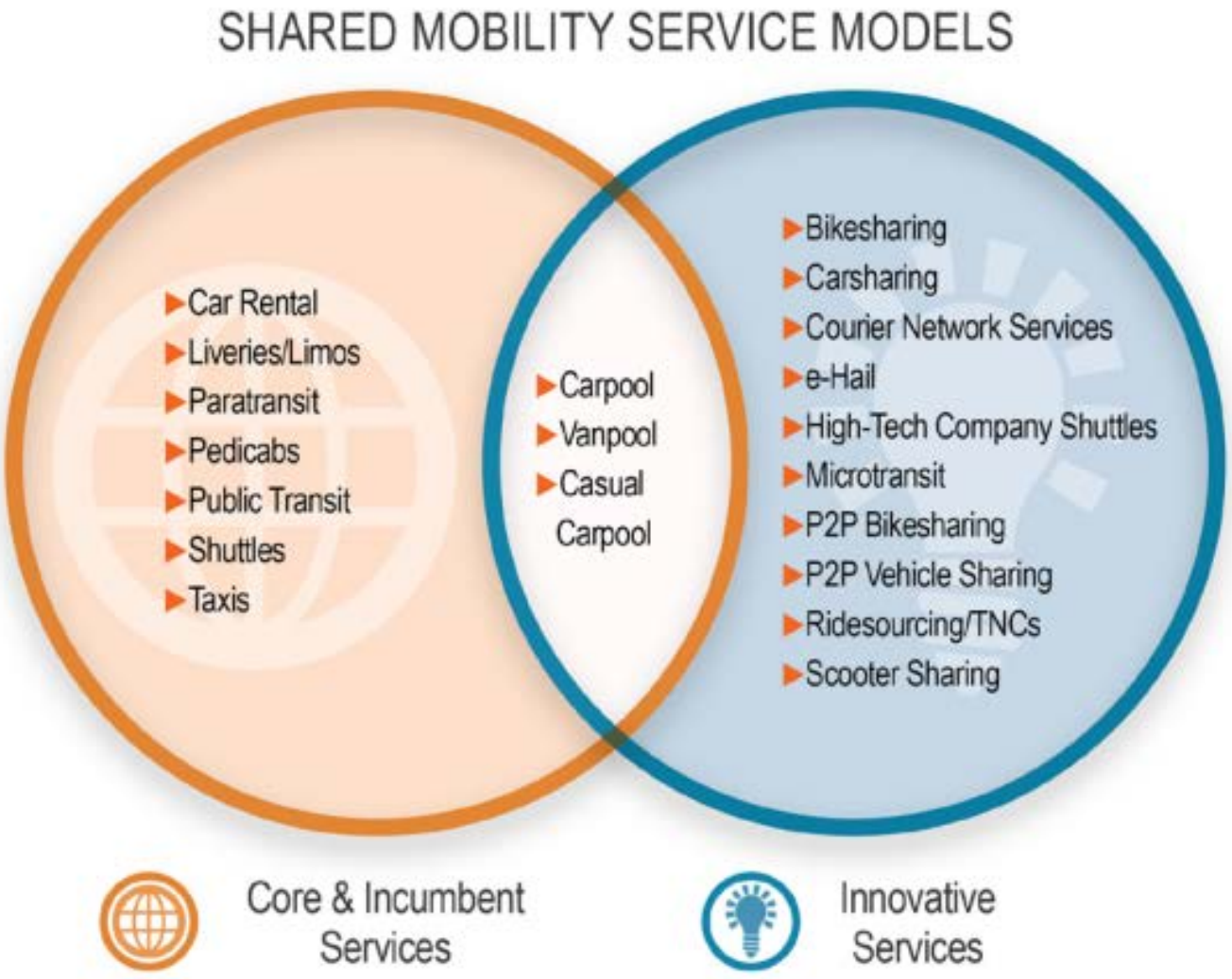
RESEARCH CENTER

Overview

- Shared Mobility & Impacts
- Role of Automation
- Shared Mobility & Built Environment
- AV Policy Development
- AV Opportunities & Challenges
- Upcoming & Recent Research

What is Shared Mobility?



Shaheen et al., 2016

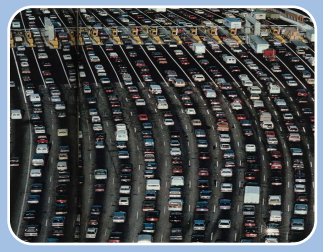
Shared Mobility Impacts

Environmental Effects

- Can yield lower GHG emissions via decreased VMT, low-emission vehicles, carbon offset programs
- Can reduce vehicle ownership

Social Effects

- Offers "pay-as-you-go" alternative to vehicle ownership
- Reasonable for college students and low-income households
- Can increases mobility of low-income residents, disabled, and college students
- Provides car use without bearing full ownership cost



Transportation Network Effects

- Takes cars off the road via reduced VMT, forgone/delayed vehicle purchases or sale of vehicle
- Reduced parking demand
- Can complement/complete with alternative transportation modes, e.g., public transit, walking, biking, etc. , and can help address first and last mile issue

Recent Study of One-Way Carsharing

ONE-WAY CARSHARING IMPACTS

Member Vehicle Holdings

2% - 5%	sold a vehicle
1 - 3	vehicles sold per car2go vehicle
7% - 10%	postponed a vehicle purchase
4 - 9	vehicle acquisitions suppressed per car2go vehicle

1 car2go vehicle replaces 7-11 vehicles

=

or 28,000 vehicles across 5-city study

Reduction of VMT and GHG emissions

- 6% - 16% Average reduction of VMT per car2go household
- 4% - 18% Average reduction of GHG emissions per car2go household

Martin et al., 2016

Vehicle and GHG Impacts from Free-Floating One-Way Carsharing

City	Vehicles Sold	Vehicles Suppressed (foregone purchases)	Total Vehicles Removed per Carsharing Vehicle	Range of Vehicles Removed per Carsharing Vehicle	% Reduction in VMT by Car2go Hhd	% Reduction in GHGs by Car2go Hhd
Calgary, AB (n=1,498)	2	9	11	2 to 11	-6%	-4%
San Diego, CA (n=824)	1	6	7	1 to 7	-7%	-6%
Seattle, WA (n=2,887)	3	7	10	3 to 10	-10%	-10%
Vancouver, BC (n=1,010)	2	7	9	2 to 9	-16%	-15%
Washington, D.C. (n=1,127)	3	5	8	3 to 8	-16%	-18%

Martin and Shaheen, 2016

Key Considerations for Replacing Private Vehicles

- Density & built environment (e.g., urban form/walkability, higher density, land use, mixed-use, transit oriented development, etc.)
- Availability & affordability of multi-modal options
- "Network effect" and right scaling
- High reliability with both on-demand and reservation capability
- Availability of real-time information services and convenient fare payment options
- Supportive public policy (users & operators)

Convergence

Electrification

Mobile Technologies

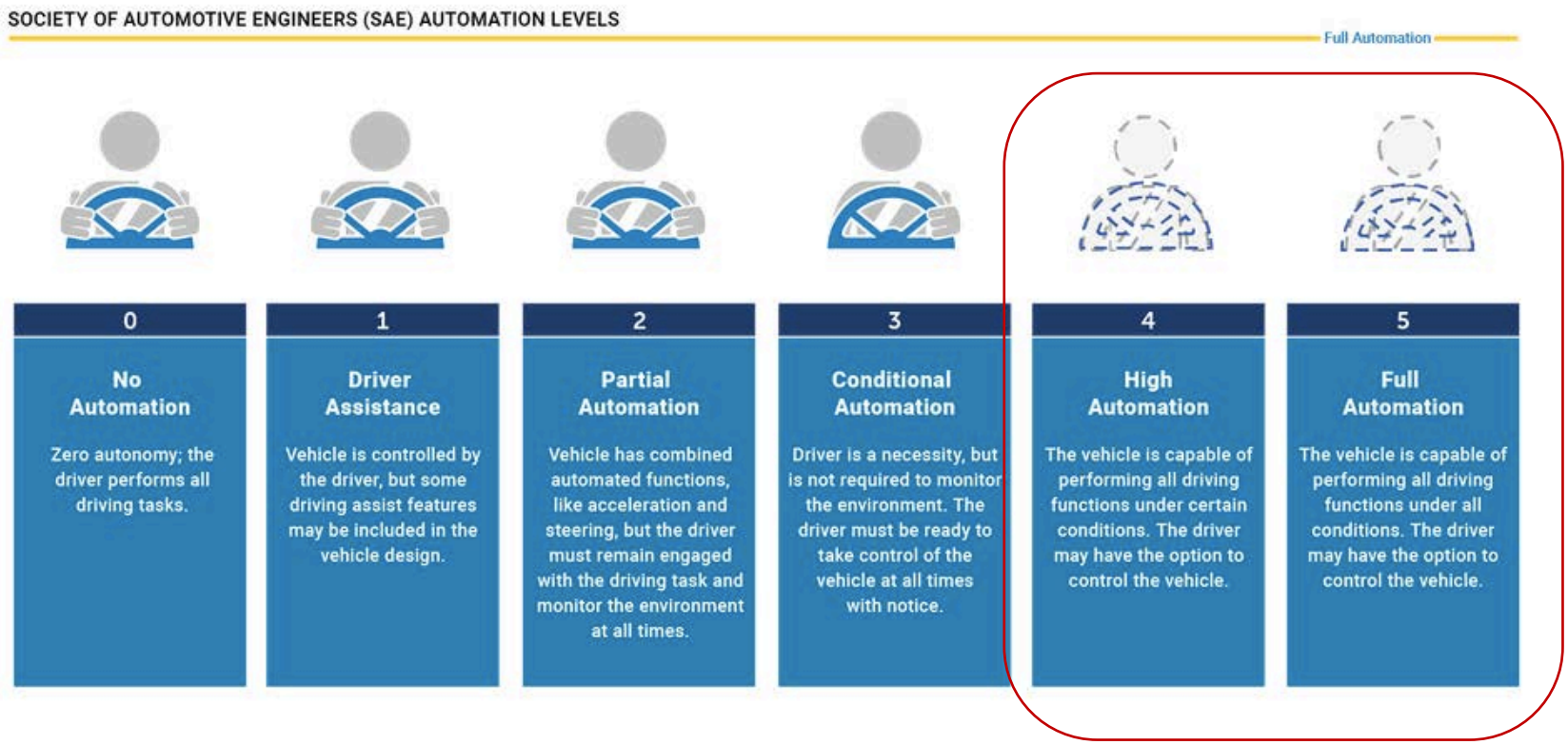
SECA

T. Papandreou, 2016

Shared Mobility

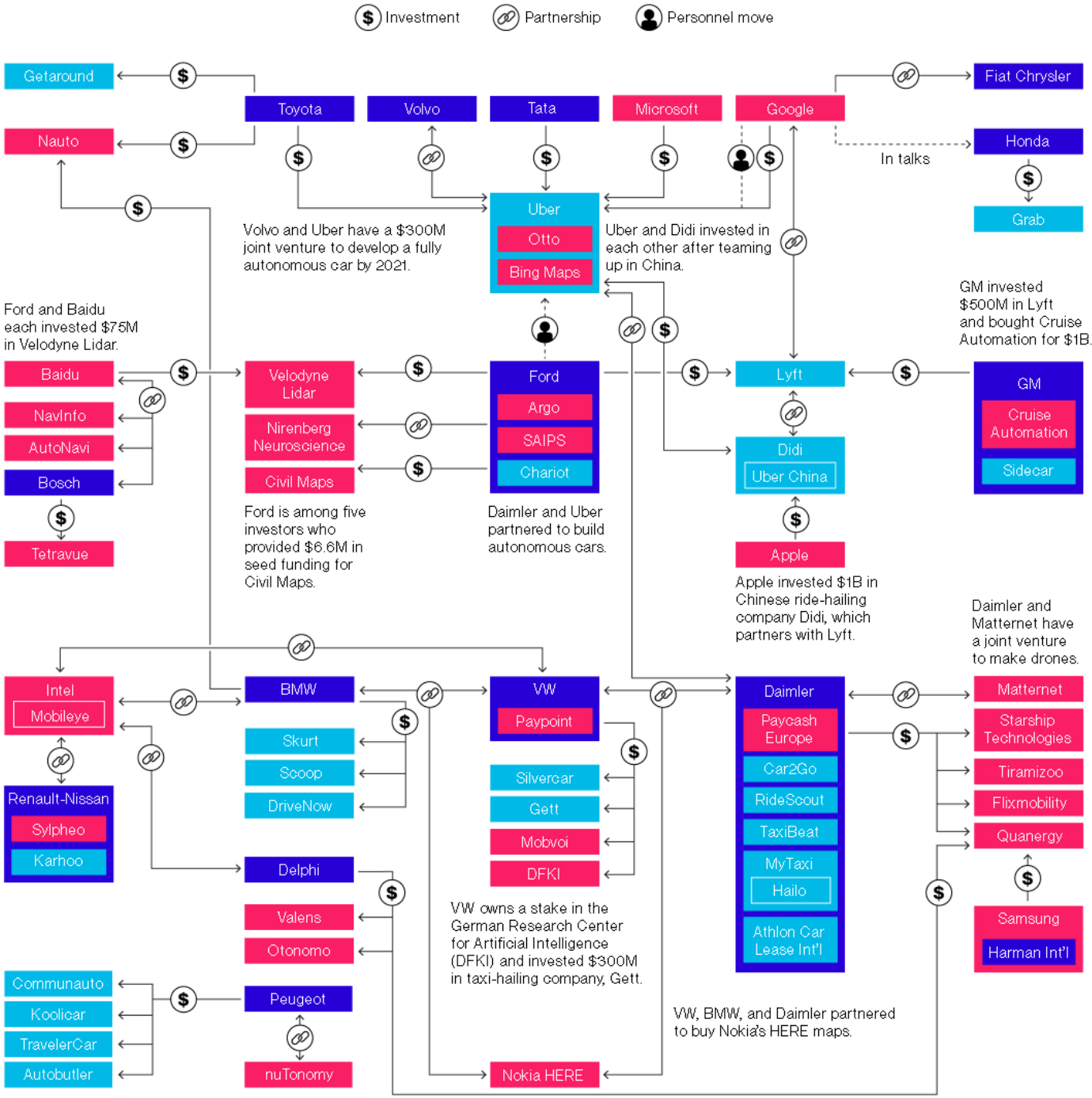
Automation

Levels of Automation



NHTSA, 2017

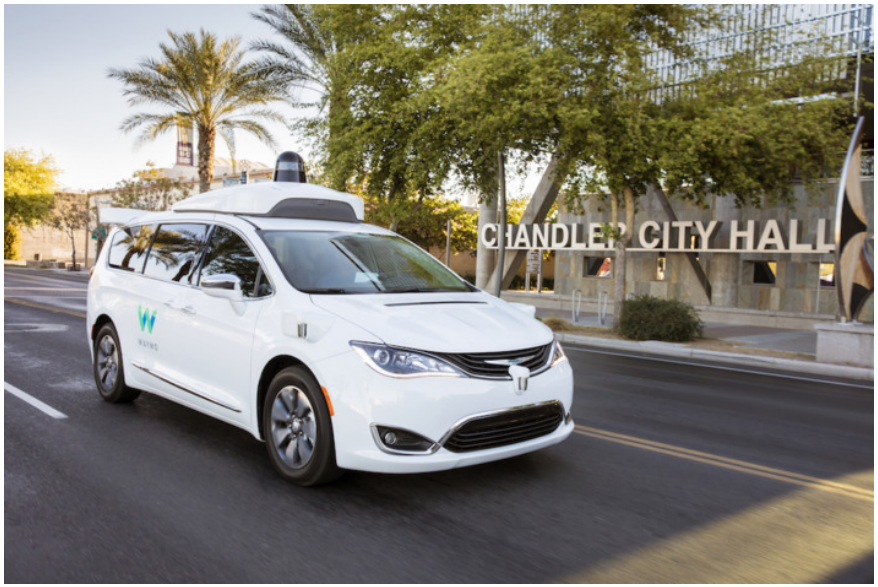
Shared Mobility & Automation Developments



Source: Data compiled by Bloomberg
Additional work: John Lippert, Keith Naughton, Cedric Sam and Kevin Tynan

Conventional Vehicle SAV Developments

Waymo Early Rider Program, Phoenix, AZ



- Alphabet's Waymo launched its Early Rider program in April 2017, inviting residents of certain areas of Phoenix, Arizona to ride in their autonomous vehicles
- After a trial period in Phoenix, Waymo plans to expand its fleet from 100 to 600 autonomous Fiat-Chrysler Pacifica Hybrid minivans

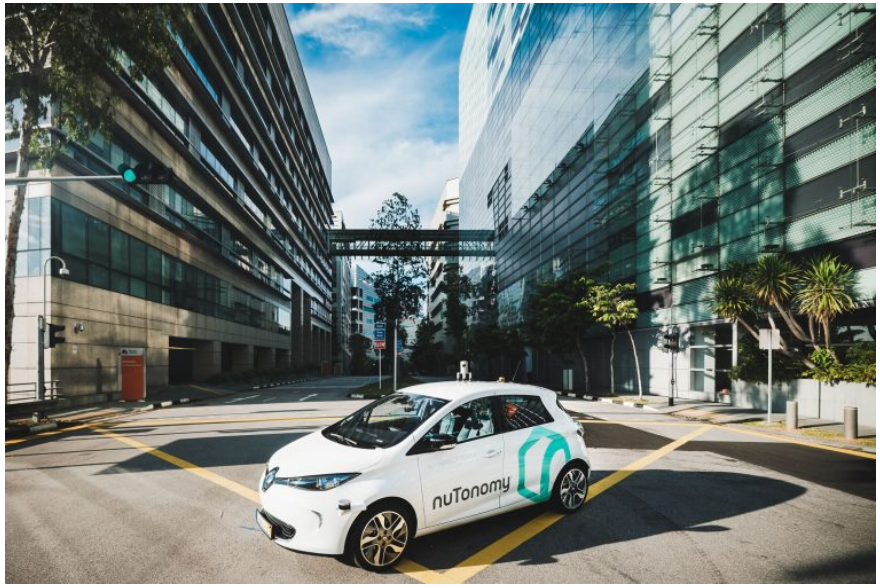
Conventional Vehicle SAV Developments

Uber, Pittsburgh, PA

- In September 2016, Uber began a pilot in Pittsburgh, PA serving around 1,000 select Uber customers with four autonomous Ford Fusions
- There is a backup driver and engineer present in the front seats

Conventional Vehicle SAV Developments

NuTonomy, One North Business Park, Singapore



- In August 2016, NuTonomy launched a public trial of their autonomous vehicles in a 1.5 square-mile section of Singapore, called One North
- NuTonomy partnered with Grab, the Southeast Asia-based ridesourcing company, and vehicles can be hailed via smartphone through Grab's platform

Planned SAV Pilots - Shuttles

Low-Speed SAV Shuttle Pilots

EasyMile, Treasure Island, San Francisco Bay Area, CA

- EasyMile and the San Francisco County Transportation Authority are planning a pilot to serve first and last mile public transit trips on Treasure Island by 2020

Local Motors Olli, Miami Dade County, FL and Las Vegas, NV

- Local Motors' Olli has been tested in National Harbor, MD and has expansion plans to serve passengers in Miami and Las Vegas

Planned SAV Pilots – Conventional Vehicles

Conventional Vehicle SAV Pilots

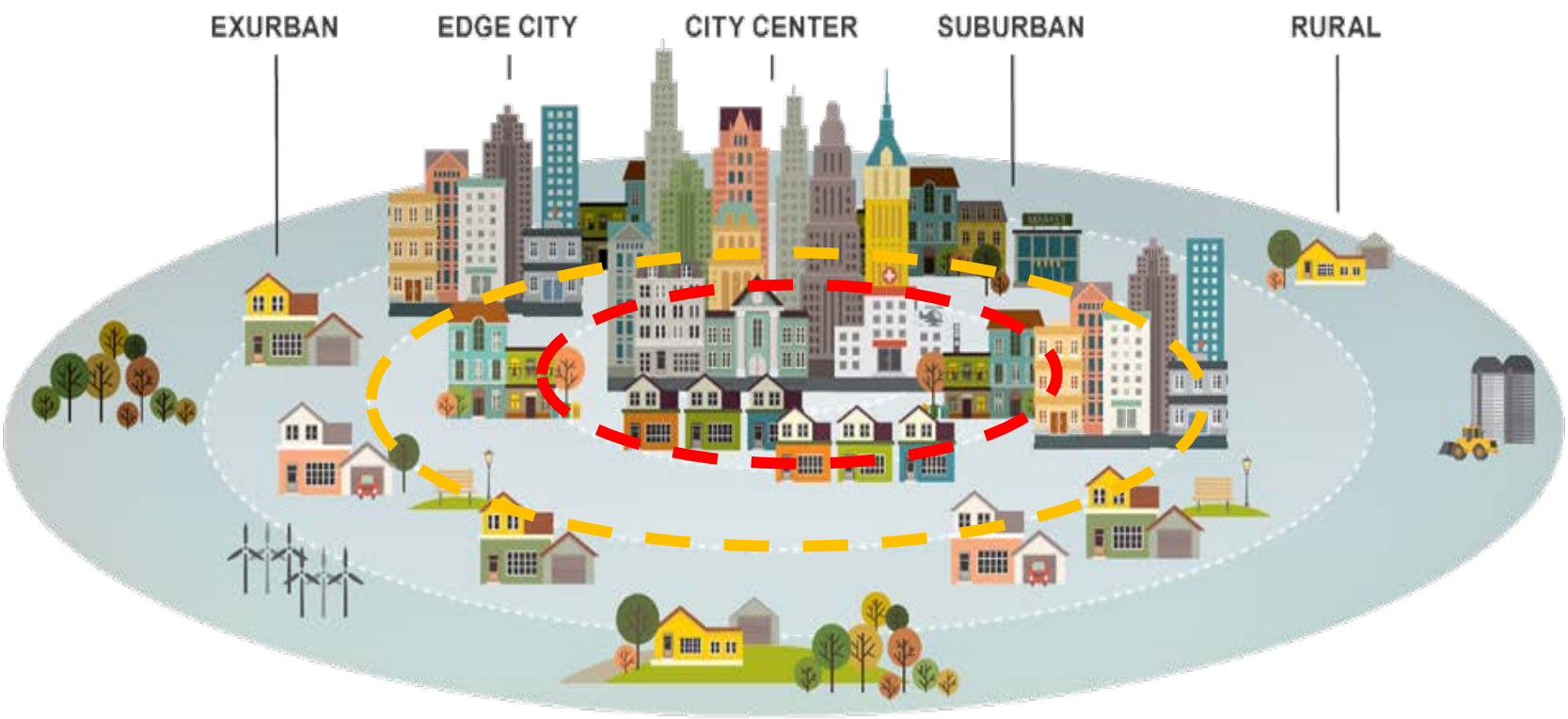
NuTonomy and Lyft, Boston, MA

- NuTonomy has been testing its AVs in the Seaport and Fort Point areas of Boston since April 2017
- In June 2017, Lyft and NuTonomy formed a partnership with plans to deploy a SAV pilot serving passengers sometime in the coming months

Delphi and Transdev, Normandy and Paris, France

- In June 2017, Delphi and Transdev announced that they will test AVs in Normandy and outside Paris in advance of building a commercial service starting in 2019, which could be deployed in other markets, including North America

Shared Mobility Ecosystem



10+ Years?

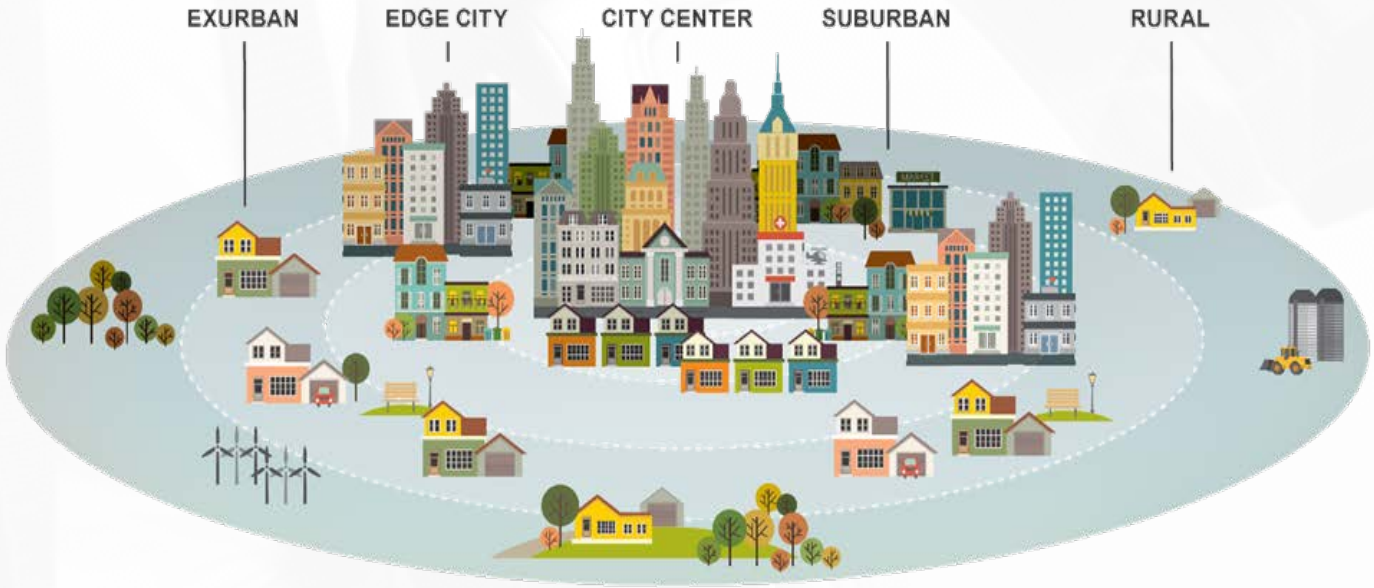
25+ Years?

Shaheen et al., forthcoming

10+ and 25+ Year Outlook?

- Deployments, modes, and propensity to sell a private vehicle will likely by asymmetric and region-specific

- Potential bifurcation of private vehicle ownership
  - Some may move to urban centers and use SAVs
  - Others may move farther from urban centers use privately owned AVs



10- and 25-Year Outlook?

- Shared modes will likely vary based on density and built environment (e.g., urban form/walkability, higher density, land use, mixed use, transit oriented development, etc.)
- 10+ Year?: Growth of shared mobility in urban centers (highest density and most walkable/bikeable)
- 10-25: Year? – Growth of shared mobility in edge cities and "inner ring" suburbs (medium density, somewhat bikeable/walkable)
- 25 Years and Beyond?: Suburbs and other less walkable/bikeable locations (adoption contingent upon availability of affordable SAV service in lower density environments)

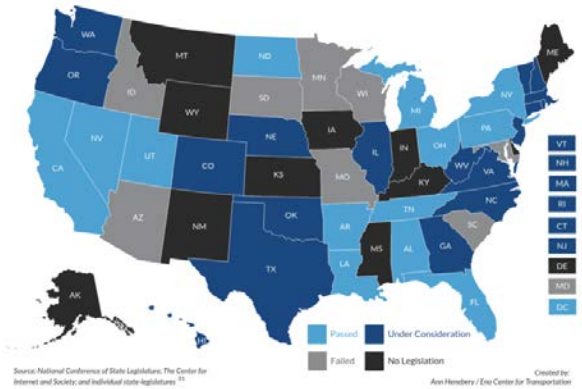
AV Policy Developments - Local

- Local AV policy will likely regulate AV/SAV operations, rights-of-way access, and local taxation
- A number of the CityMobil2 pilots in Europe allowed low-speed SAVs on public roads employing a local ordinance

Important in regulating SAV ops, traffic mitigation + equity implications

AV Policy Developments - State

- State AV policy will likely regulate liability and insurance, licensing, traffic laws, and infrastructure
- 18 states have enacted AV laws, 70 state bills have been considered in 2017 alone
- Different states taking different approaches to regulating AVs
  - California has been closely regulating AV testing
  - Florida and Michigan passed less stringent AV regulations
  - Some states have no enacted AV-specific legislation, allowing AV operations in some circumstances



Liability, insurance, licensing, traffic laws + infrastructure

NCSL and Eno, 2017

AV Policy Developments - Federal

- Federal AV policy will likely regulate *vehicle design standards* (FMVSS), *vehicle and consumer safety*, and *exemptions*
- Federal Automated Driving Systems Guidance (September 2017) contains 12 priority safety design element (goals/approaches)
- HR 3388 (referred to Senate on 9/7/17)
  - Prohibits state/local laws or regulation regarding *design*, *construction*, or *performance* of highly automated vehicles, automated driving systems, or components unless prescribed by law
  - States/local governments may continue standards that conform to federal standards

Safety + Design Focus

Potential Future SAV Policy Developments

- SAV-specific policy is sparse, at present
- Potential adverse impacts of AVs/SAVs will have to be considered when crafting SAV regulations (e.g., induced demand)
- Both Massachusetts and Tennessee have proposed bills that consider imposing a mileage-based operating fee on AVs
- A number of USDOT Smart City Challenge proposals included access to rights-of-way regulations for AVs and SAVs

Possible SAV Impacts: Opportunities

- Enhanced safety (elimination of human factor errors)
- Increase vehicle occupancies (freed capacity, right-sized vehicles, closer spacing, etc.)
- Reduce per mile cost (over privately owned vehicles)
- Unlock urban space dedicated to parking for other uses
- Downsize number of privately owned household vehicles
- Reduce GHG emissions

Possible SAV Impacts: Challenges

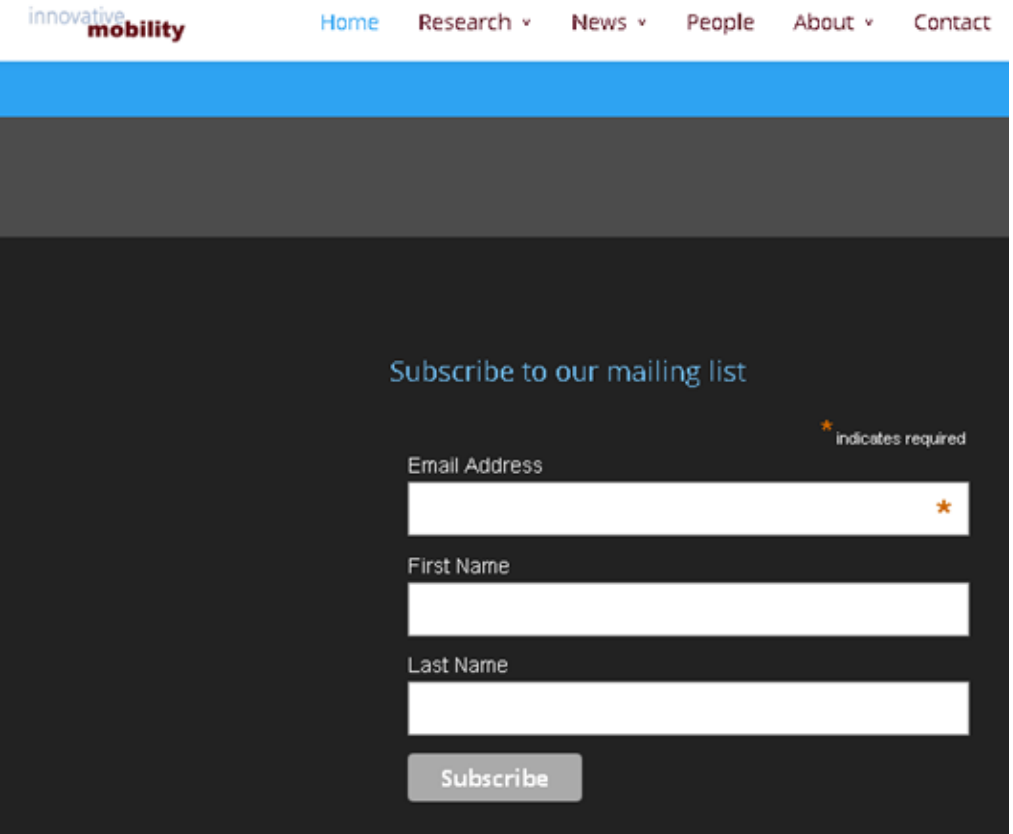
- Increased VMT (due to induced demand b/c lower costs, modal shift away from public transit, longer commutes, roaming AVs, etc.)
- Will people give up private ownership?
- Increased urban sprawl
- Congestion solved?

Future Shared Mobility Research

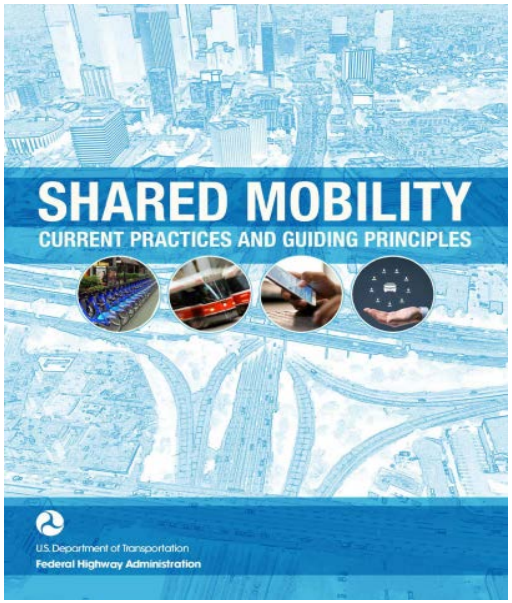
- North American and International Carsharing Market Outlooks (Winter 2017)
- Impacts Study of Lyft and Uber (Winter 2017)
  - Study will assess the impacts of travel behavior, vehicle ownership, VMT, modal shift, and GHG emissions
- P2P Carsharing Impact Study (Fall 2017)
- Bikesharing GHG Study (Fall 2017)

Innovative Mobility Highlights, Carsharing Outlook, and Latest Research

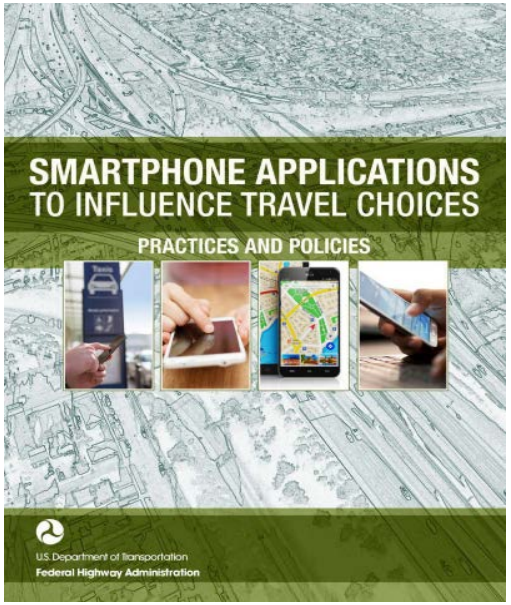
Subscribe for the latest updates (Innovative Mobility Highlights, Carsharing Outlooks, Policy Briefs, Research Highlights and more) at: www.innovativemobility.org (bottom of home page)



Recent Reports



https://ops.fhwa.dot.gov/publications/fhwahop16022/fhwahop16022.pdf



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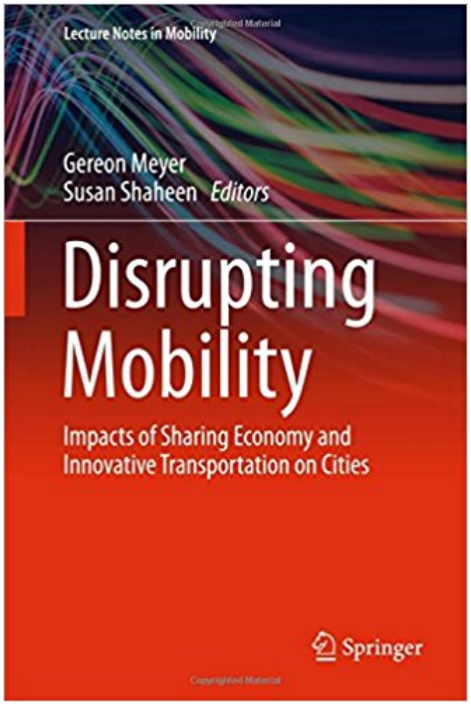
https://www.planning.org/publications/report/9107556/

Recent Book: Disrupting Mobility



Available at:

https://www.amazon.com/Disrupting-Mobility-Impacts-Innovative-Transportation/dp/3319516019

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