Connected and Automated Vehicles

Jay Hietpas, P.E.

Connected and Automated Vehicles Director

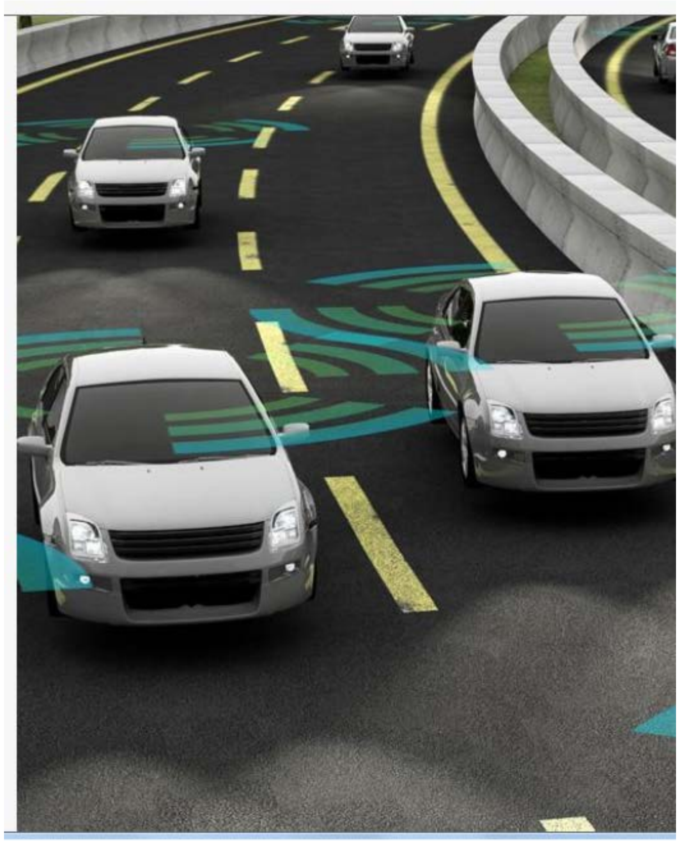
DEPARTMENT OF TRANSPORTATION

TOWARD ZERO DEATHS

Presentation Overview

- Connected and Automated (CAV) Background

- CAV Activities in Minnesota



Connected Automation

Autonomous Vehicles

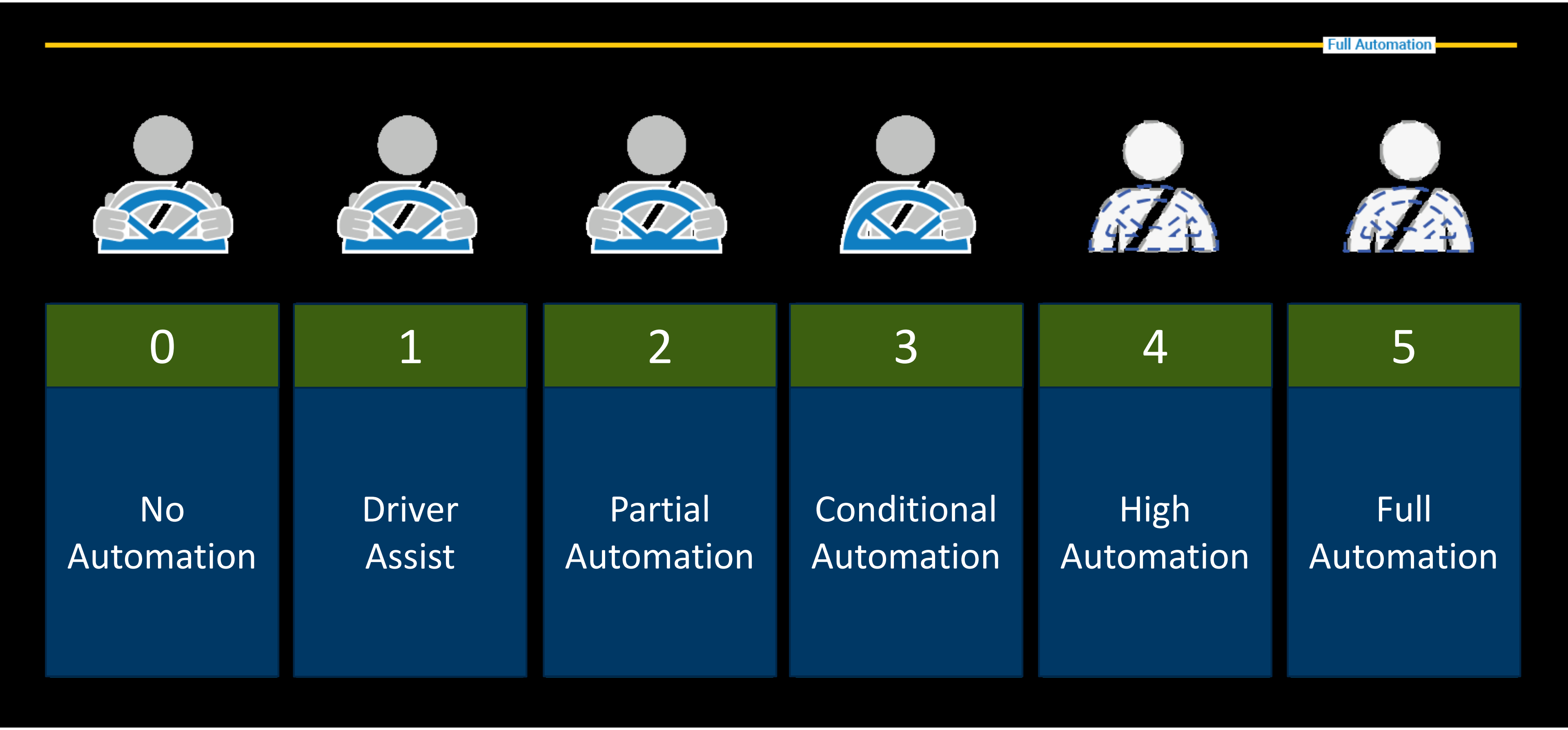
Operates in isolation from other vehicles using sensors

Connected Automated Vehicle

Uses connected and automated technologies

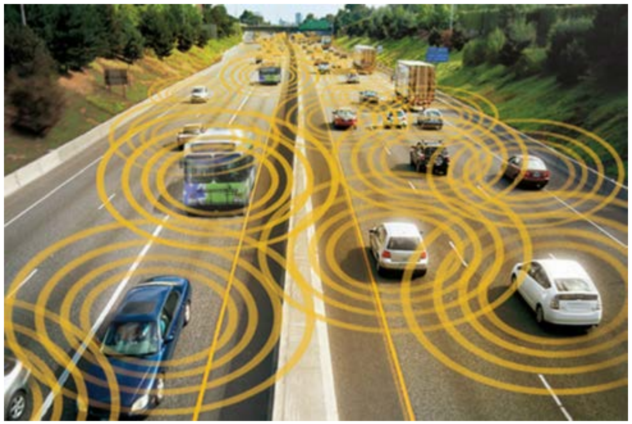
Connected Vehicles

Communicates with vehicles and infrastructure



Society of Automotive Engineers (SAE) Levels of Automation

Items Being Considered

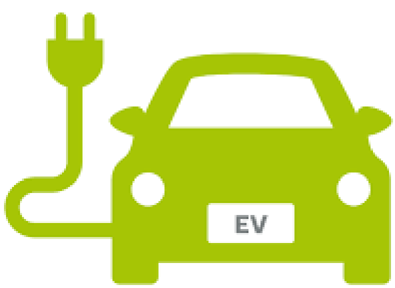


Automated & Connected Vehicles

Truck Platooning

Mobility as a Service
(MAAS)

Automated Delivery Services



Electric Vehicles

CAV - When Will It Come?

GM will make an autonomous car witho ering wheel or pedals by 2019

87

'Platoons' of auto trucks will dr

to buy up to tonomous les from Volvo

To exus to introduce DSRC-based con d vehicles in the USA from 2021

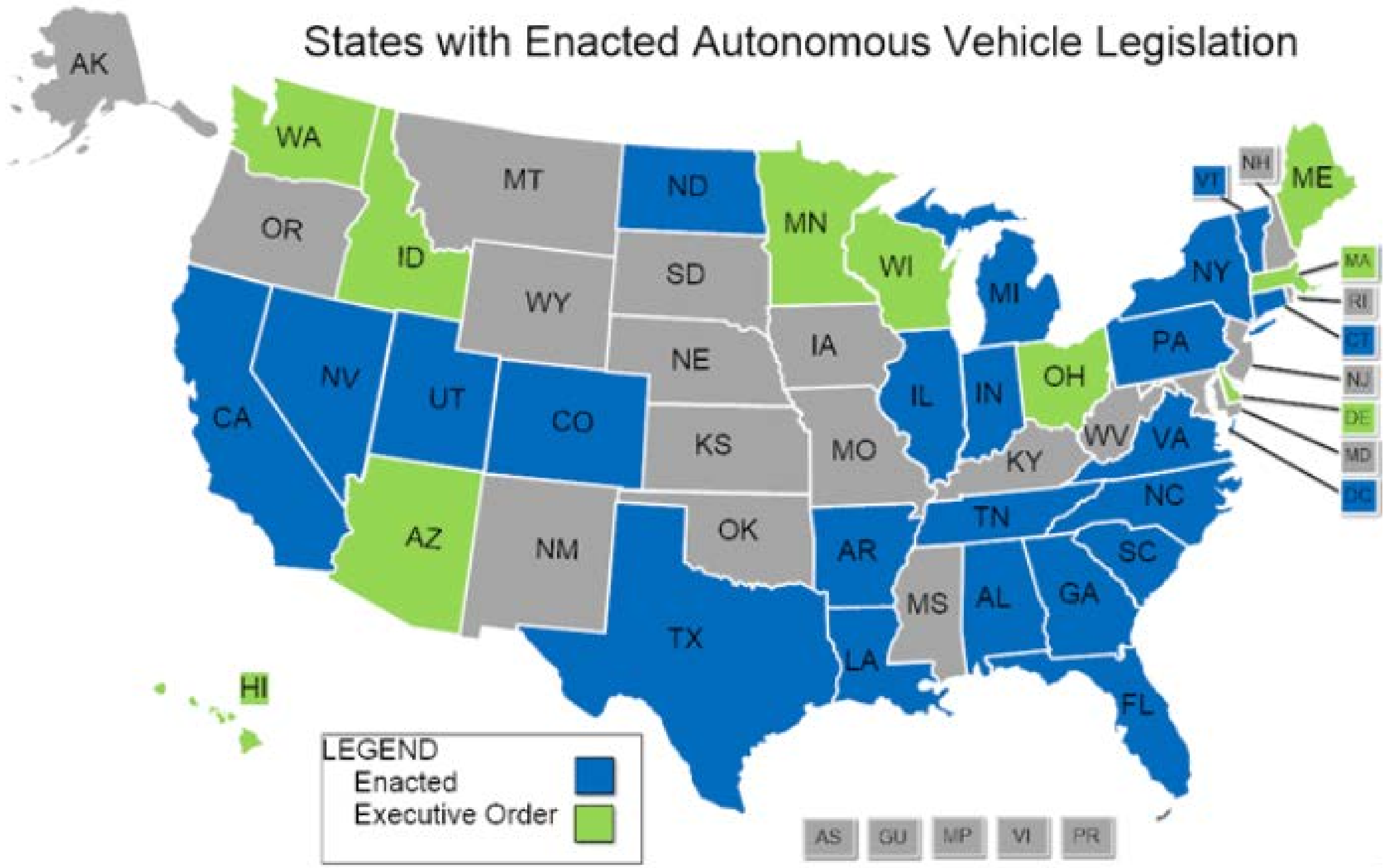
Consumer Availability and Market Penetration Rates

????

Pieces of Automation Already Available

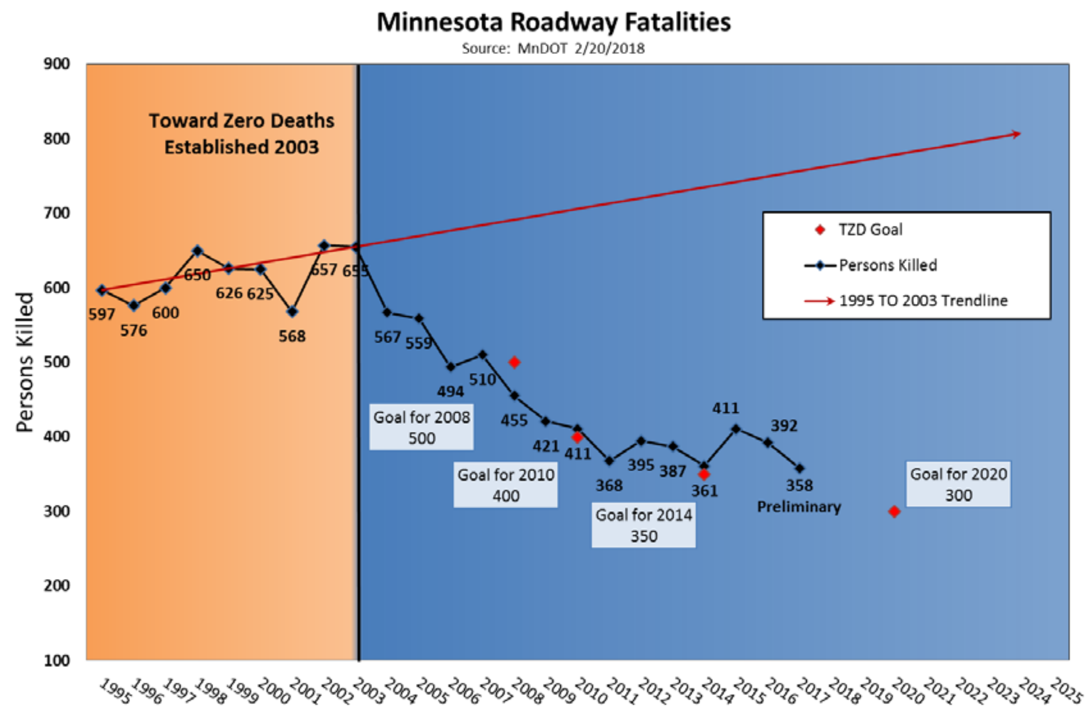
- Adaptive Cruise Control
- Self Parking Features
- Lane Departure Systems
- GM Super Cruise / Tesla Auto-Pilot
- V2I – Signal Systems (Audi, BMW, Apps)
- Self Driving Tests

National Items



What is the Impact to Minnesota?

- Safety
- Changes in operations
- Infrastructure Changes
- Regulation
- Mobility Opportunities
- Business Opportunities

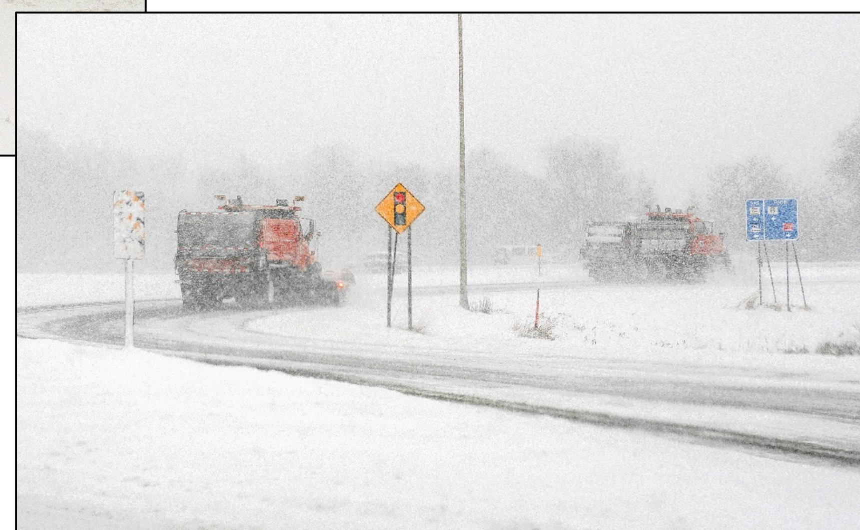


TOWARD ZERO DEATHS

What are the Challenges?

Snow / Ice

Salt



Other Impacts

Parking Impacts

Freight

Cyber Security

Pavement Markings

Geometric Design

Licensing Laws

Bridge Loads

Smart Signs

Pavement Impacts

Traffic Operations

Revenue

Mixed Traffic (AV & Non-AV)

Staffing

Land Use / Planning

Activities in Minnesota

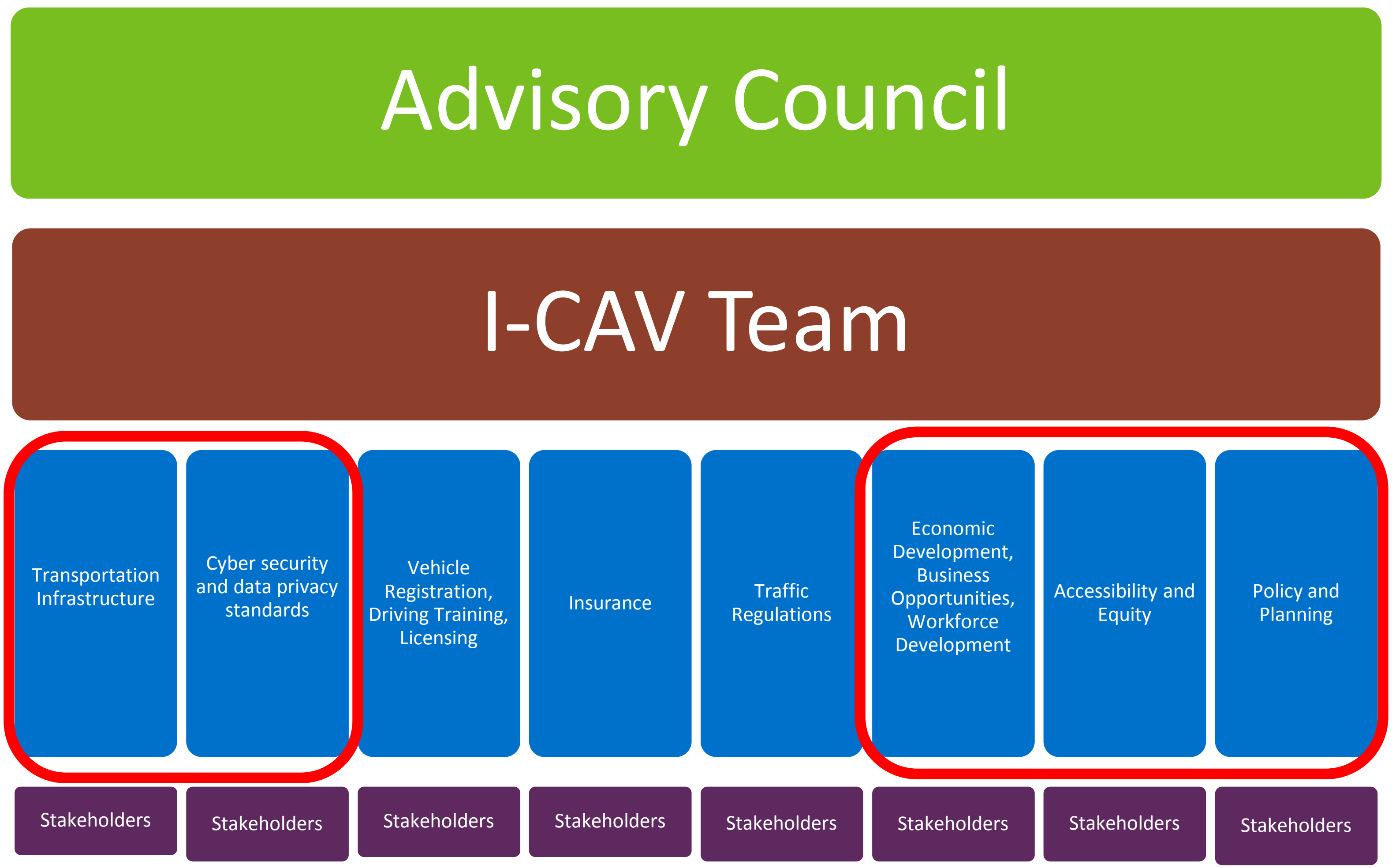
- CAV-X Office
  - Policy
  - Research & Implementation Funding
- CTS Automated Vehicle Visioning Workshop
- Executive Order 18-04
- MnDOT CAV Strategic Plan
- Autonomous Shuttle Testing
- Connected Corridors Project

Executive Order – Expected Outcomes

Advisory Council

- Study, assess, and prepare for the transformation and opportunities associated CAVs
- Develop recommendations for changes in state law
- Submit Report to Legislature by December 1, 2018.
- Establish programs for development, testing, and deployment;

Minnesota Connected and Automated Vehicles EO Organization Structure



MnDOT CAV Strategic Vision

Safe Automated Vehicle Testing Demonstration

Project Goals

- Snow and Ice Testing
- Identify Infrastructure
- Identify Operations Impacts
- Improve Future Mobility Options
- Increase Minnesota’s Influence
- Develop Partnerships
- Public Feedback

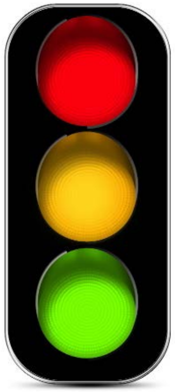
Downtown Minneapolis - Nicollet Mall Demo

TOTAL riders for the 3 day demo: **1279**

Connected Vehicles Corridor

Connected Vehicle Applications

- 1: Signal Phase and Timing (SPaT)
- 2: Transit/Pedestrian Conflict Warning
- 3: Snow Plow Signal Priority
- 4: CV Data Exchange
- 5: Mobile Work Zone Warning System
- 6: Transit/MnPASS Lane Status Notification System



Thank you again!

Jay Hietpas, PE

CAV-X Director

Jay.hietpas@state.mn.us

Transportation Advisory Board

May 16, 2018

Planning for Connected and Automated Vehicles

METROPOLITAN COUNCIL

Planning

The nation, state, region and local governments are facing great opportunity with automated vehicle technologies,
yet also great uncertainty as this new technology develops and is implemented across our various environments.

As yet, CAV has Uncertain Outcomes….

COULD DECREASE DUE TO	IMPLICATION	COULD INCREASE DUE TO
Vehicle sharing, higher vehicle costs	**Vehicle Ownership**	Smaller, lighter-weight vehicles lower cost, new types of vehicles
Increased travel willingness / better use of in-vehicle time	**Land Use Density**	Network effects, shared & transit vehicles, less parking
Vehicle sharing, denser development	**VMT / Trips**	Lower operating costs, zero-occupant trips, mode shift, expanded mobility for non-drivers, increased travel willingness
Follows all road rules / defensive driving	**Road Capacity / Speed**	Reduced headways, smoother traffic flow, shorter signal lag times, fewer crashes, and real-time route optimization
Machine precision	**Crashes**	Hacking, complex human-machine interactions
Low-emission vehicles, right-sized vehicles, eco-driving	**Air and Noise Pollution**	More travel, larger vehicles
Vehicles avoid deficiencies, smoother traffic flow	**Pavement Distress**	Platooning / closer vehicle spacing, increased VMT
AI (deep learning) displaces workers	**Jobs**	Technology creates more new high-skill jobs than the lower-skill ones it disrupts

Source: DVRPC, 2017. Adapted from Bryant Walker Smith, How Governments Can Promote Automated Driving, New Mexico Law Review, forthcoming, March 17, 2016, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2749375; and Johanna Zmud, Ginger Goodin, Maarit Moran, Nidhi Kalra, and Eric Thorn, Advancing Automated and Connected Vehicles: Policy and Planning Strategies for State and Local Transportation Agencies, National Cooperative Highway Research Program; Transportation Research Board, National Academies of Sciences, Engineering, and Medicine, 2017, http://nap.edu/24872.

How will autonomous vehicles arrive?

Fully Autonomous

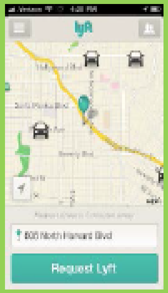
Semi-Autonomous

Driver

Personal Automation

Shared Automated/ Platooning

Business as Usual



Shared Mobility

Personally Owned

Mobility Fleets

Source: Maricopa Association of Governments

Agency Roles

Definition and understanding of various public agency roles is still evolving…..

- MnDOT
- Local governments
- University
- Transit operators
- Metro Council as the Metropolitan Planning Organization

Regional Outcomes and Goals

Successful implementation of CAV technology means positive impacts on the outcomes and goals identified by the region…..

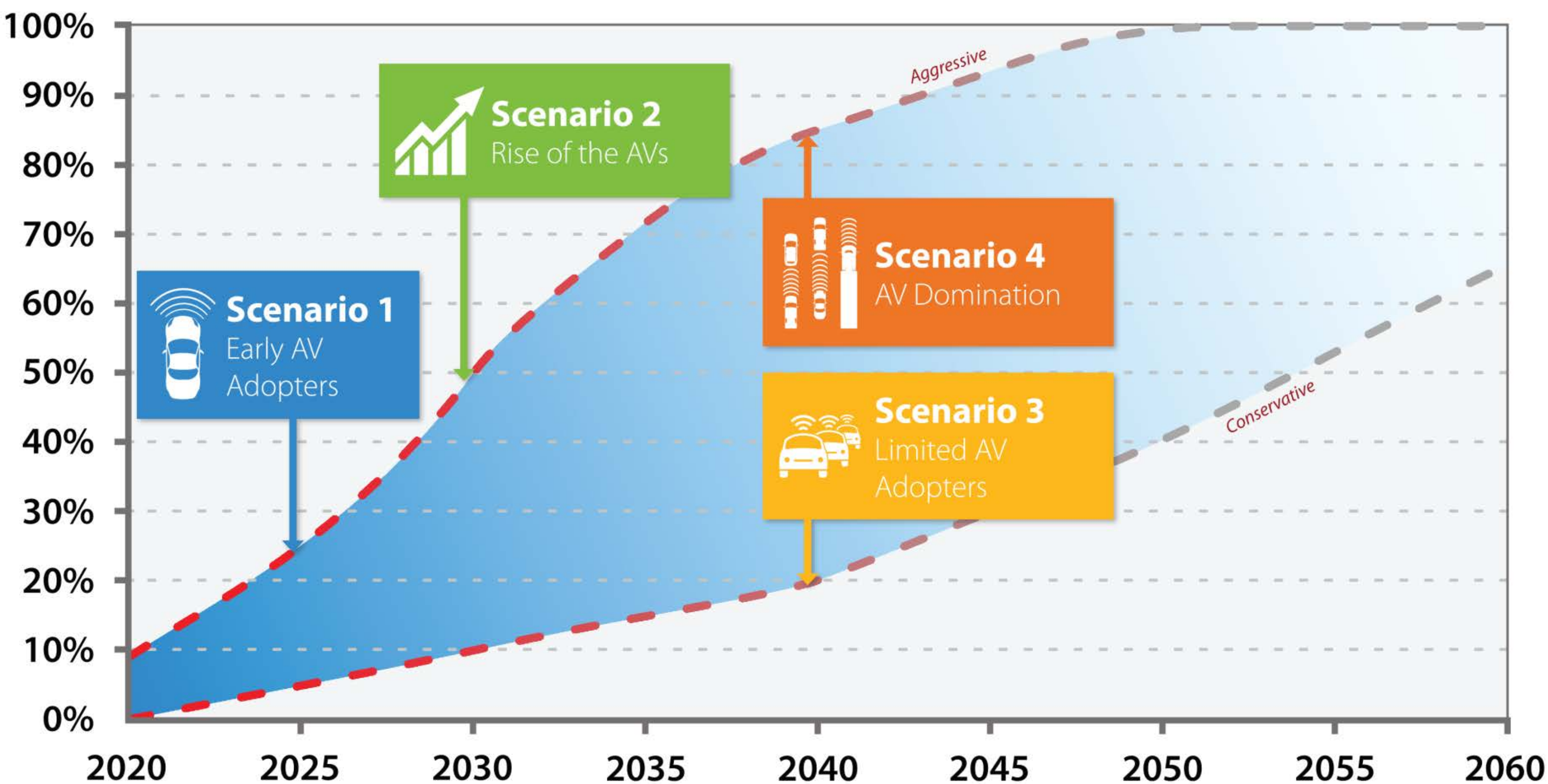
- Thrive regional outcomes: Stewardship, Prosperity, Equity, Livability, and Sustainability
- Transportation goals: System Stewardship, Safety and Security, Access to Destinations, Competitive Economy, Healthy and Equitable Communities, Leveraging Transportation Investments to Guide Land Use

Council MPO Roles

- Connect the development and deployment of CAV to regional outcomes and goals
- Provide a forum and process for policy-makers and the public to be involved
- Ensuring concerns of all modes and users are addressed
- Monitor national and state activities and trajectory of CAV adoption, share knowledge
- Scenario and performance based planning

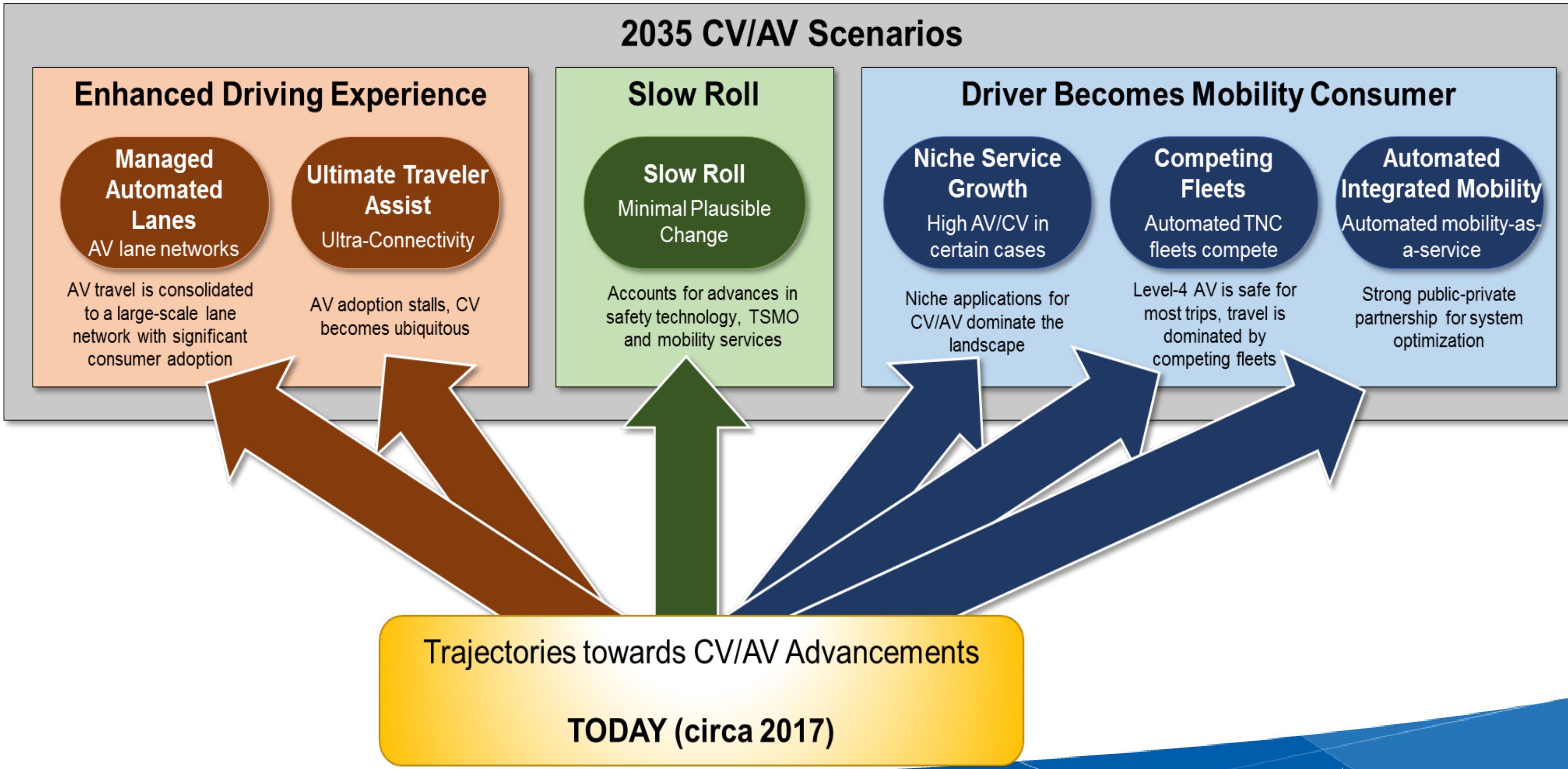
METROPOLITAN COUNCIL

Potential Penetration of AV



Source: Maricopa Association of Governments; HDR Engineering, Inc.

FHWA Scenario Planning



Council Focus Areas

MPO work efforts will focus on understanding the impacts of CAV on:

- Travel behavior
- Revenues
- Investment needs
- Equity
- Land use

METROPOLITAN COUNCIL

Work Program Activities

- Participation in local and national activities
  - Governor's CAV Advisory Council
  - MnDOT CAV Strategic Plan
  - CTS CAV Workshop June 2018
  - AMPO Draft National Framework for Regional CAV Planning
  - FHWA CAV scenario modeling
- TPP Work Program
  - Regional framework and issues analysis
  - Scenario modeling and performance measurement
  - Integrating CAVs into the Congestion Management Process
  - Emerging truck technologies
  - Transportation investment needs assessment

2017 Work
Owned/Shared Scenario Modeling

- Modeled changes in highway system performance at various levels of CAV deployment and combinations of owned versus shared CAVs
- Outcomes examined:
  - Vehicle miles traveled (VMT) and congested VMT
  - Average speeds
  - Number and % of unoccupied vehicle trips
  - % VMT occurring in unoccupied vehicles

2017 CAV Modeling Conclusions

- Number of vehicle trips and vehicle miles traveled increases substantially due to new unoccupied vehicle trips under both scenarios
- Number of congested miles increased substantially under both scenarios
- Worst case congestion scenario is during mixed fleet of CAV and non-CAV
- Number of vehicles in the region decreases under both owned and shared scenarios

Why Shared Autonomous Vehicles are Coming - Fast

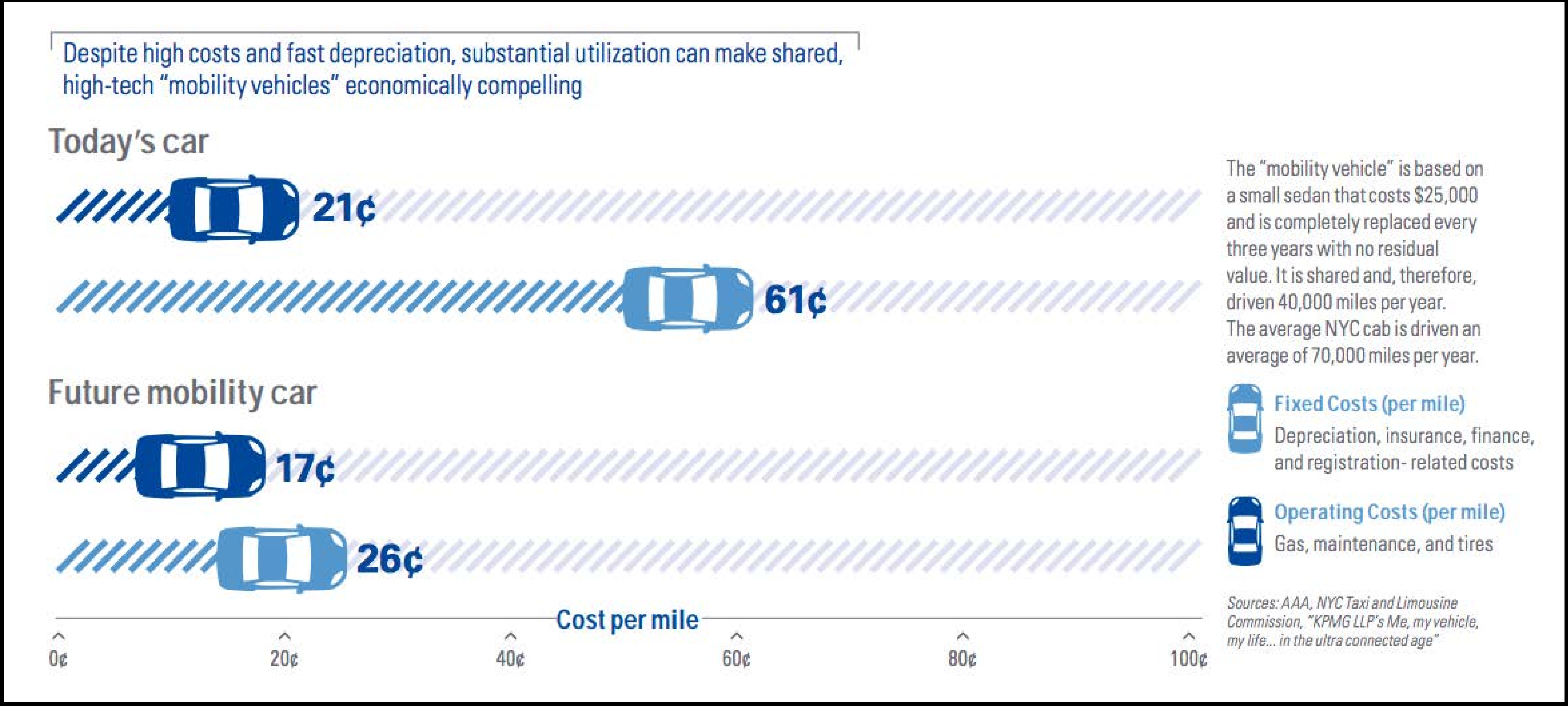
Thomas Fisher

Professor and Director

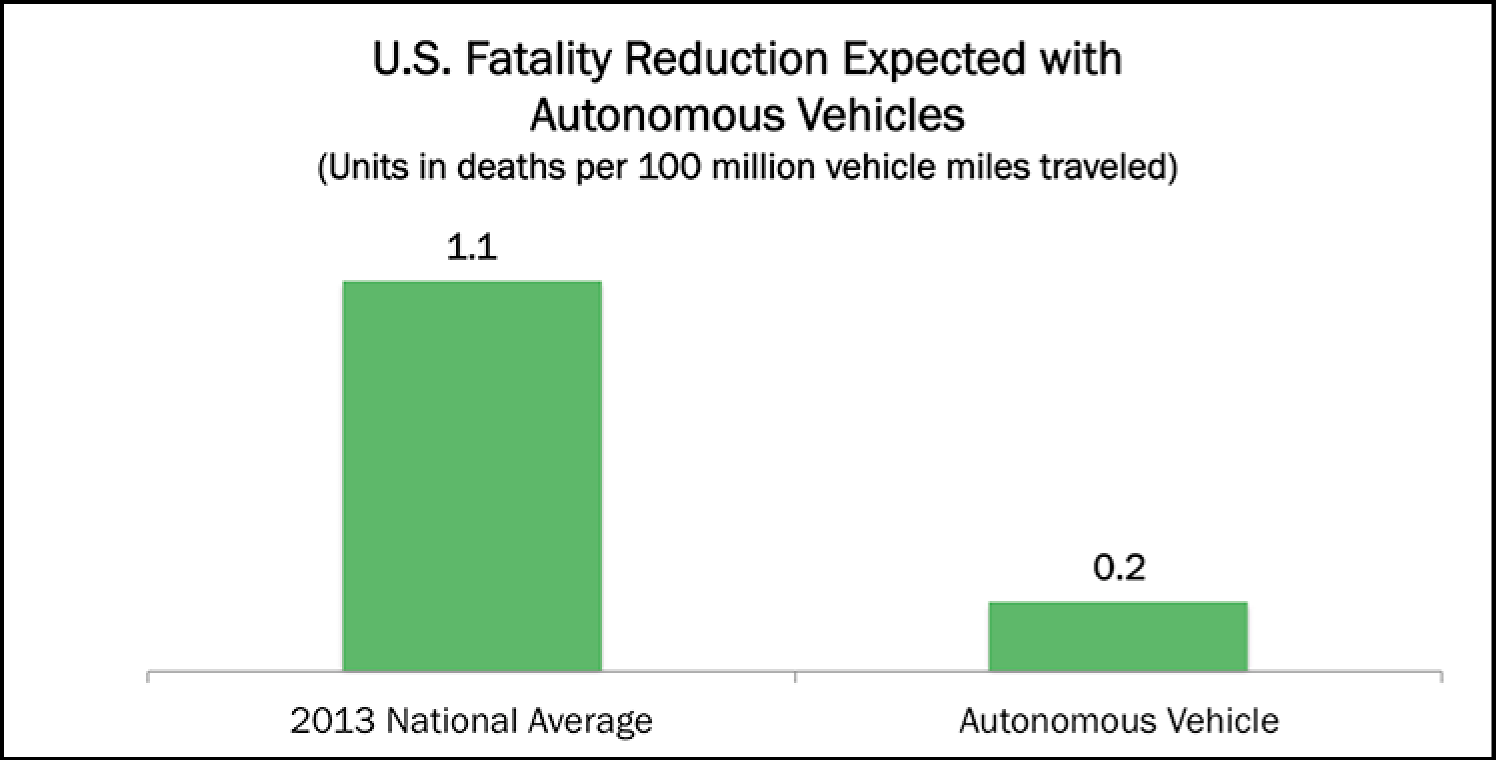
Minnesota Design Center, University of Minnesota

The change will happen faster than you think

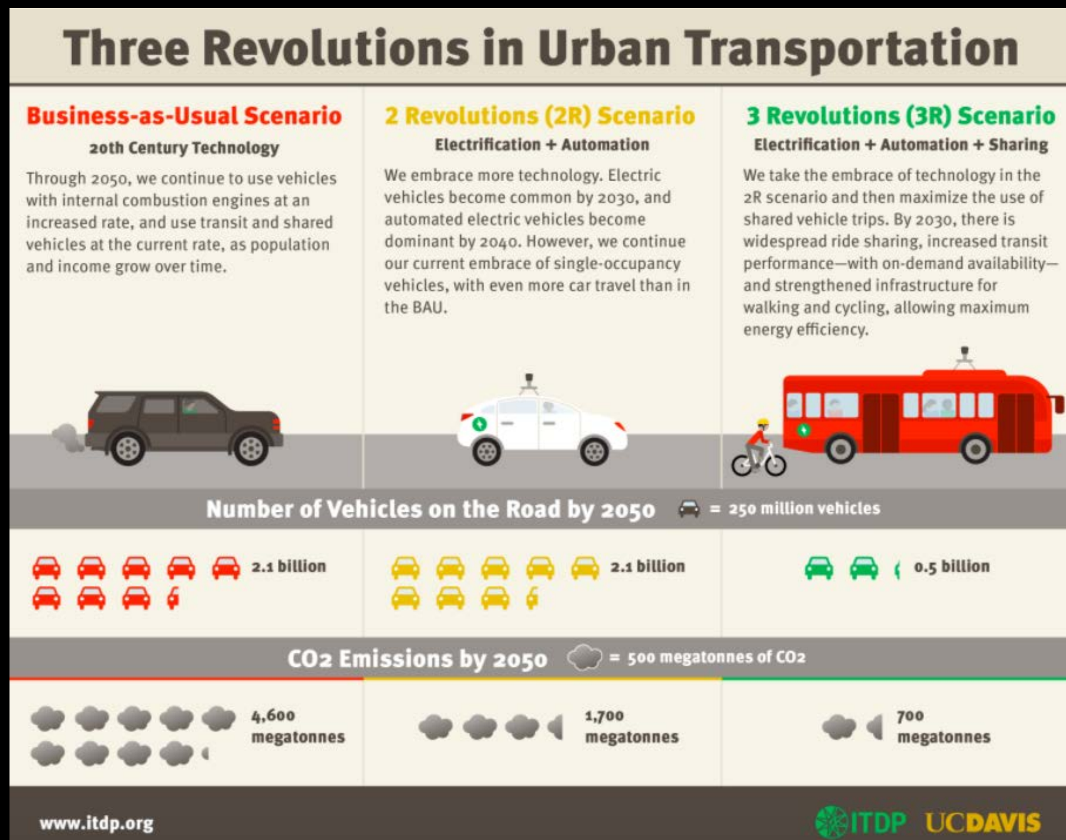
A big driver of this change: cost of driving



A second driver: safety



A third driver: reduced pollution



The big stick driving the change: insurance

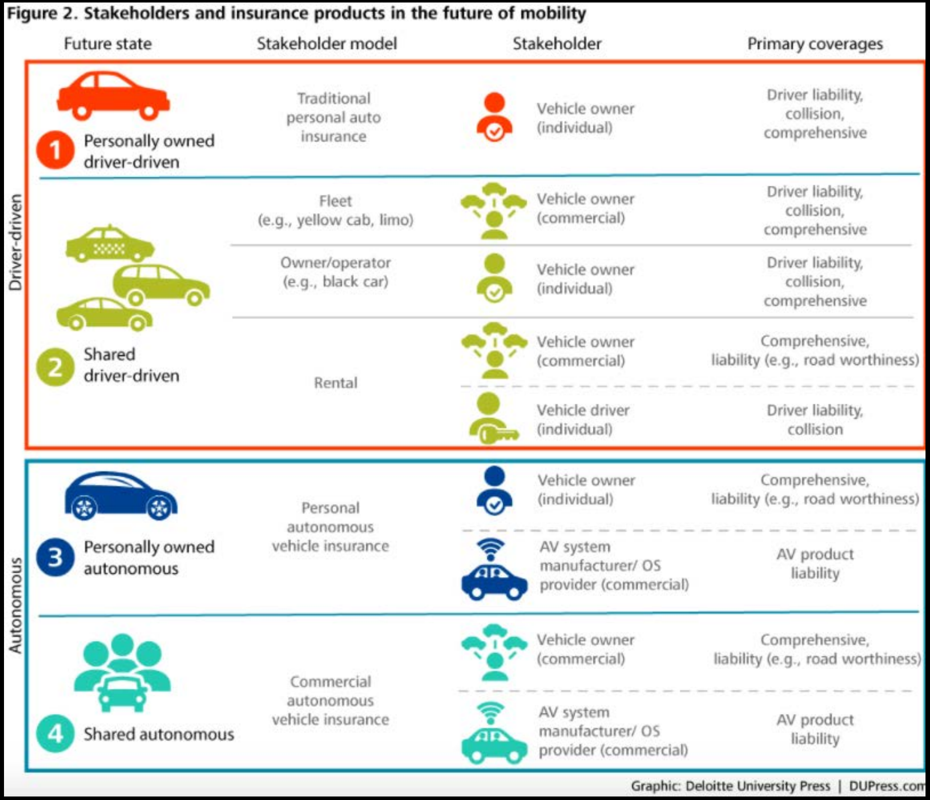
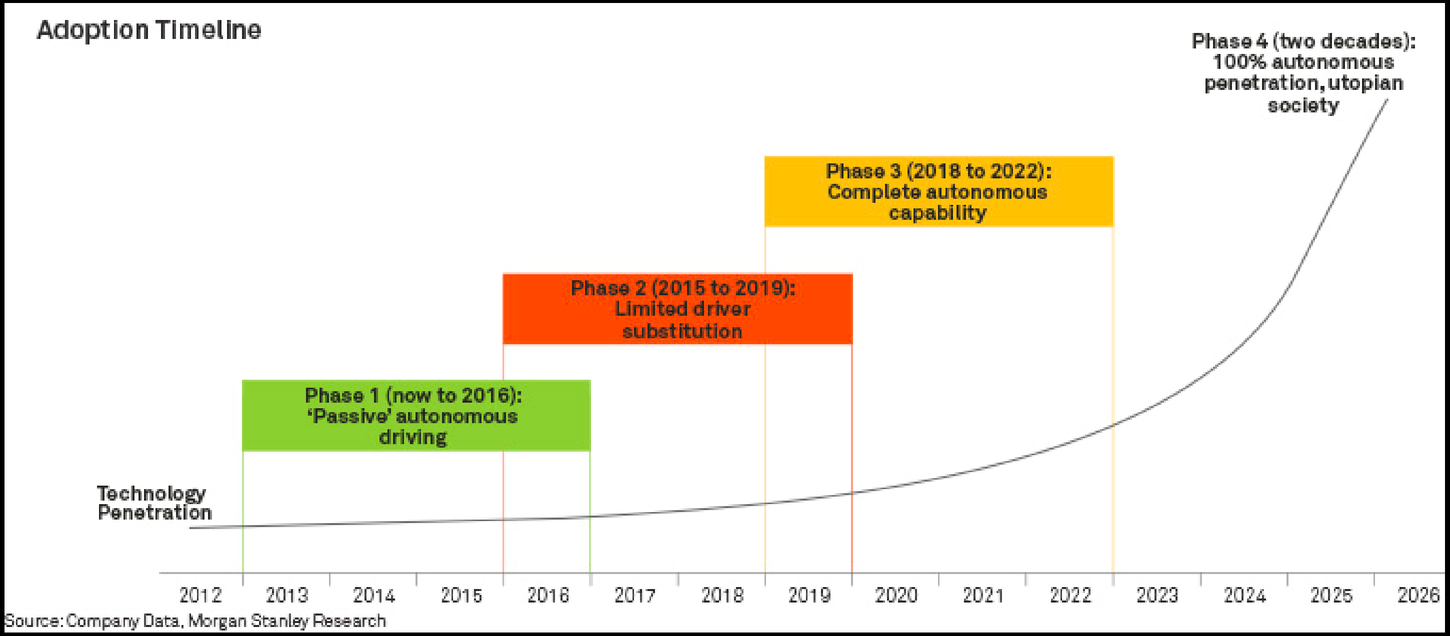


Figure 2. Stakeholders and insurance products in the future of mobility

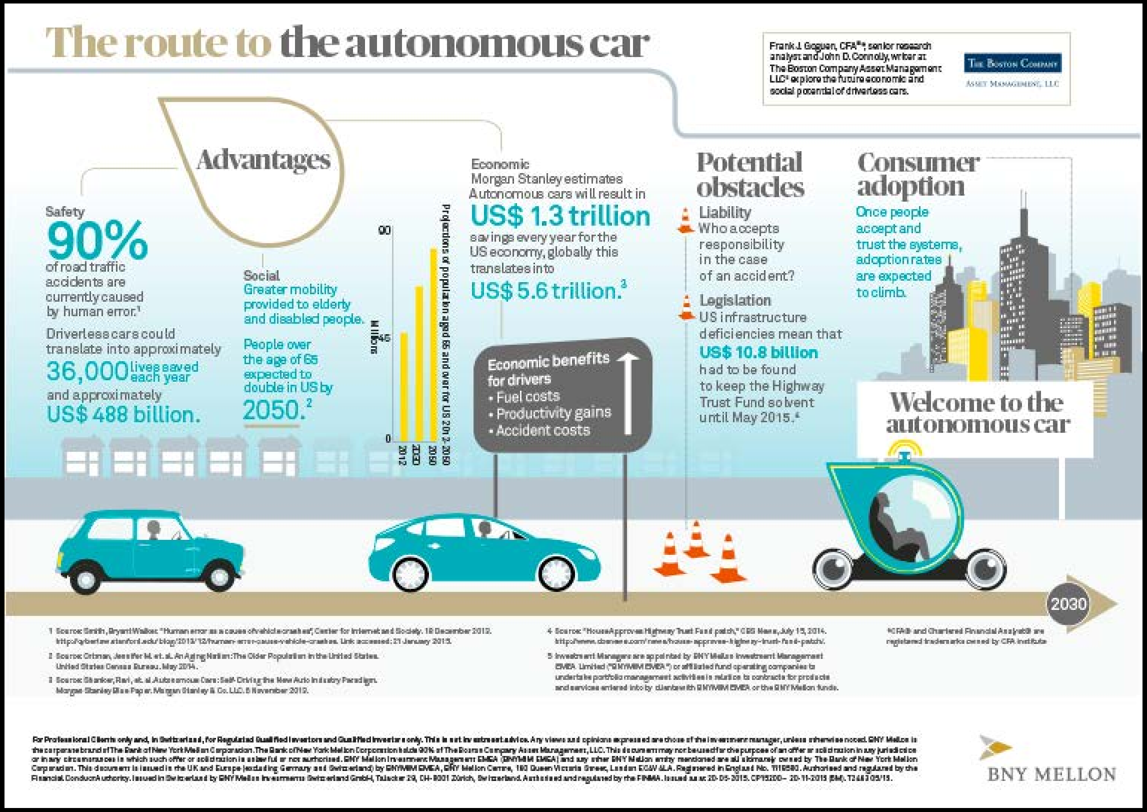
	Future state	Stakeholder model	Stakeholder	Primary coverages
Driver-driven	1 Personally owned driver-driven	Traditional personal auto insurance	Vehicle owner (individual)	Driver liability, collision, comprehensive
Driver-driven	2 Shared driver-driven	Fleet (e.g., yellow cab, limo)	Vehicle owner (commercial)	Driver liability, collision, comprehensive
		Owner/operator (e.g., black car)	Vehicle owner (individual)	Driver liability, collision, comprehensive
		Rental	Vehicle owner (commercial)	Comprehensive, liability (e.g., road worthiness)
			Vehicle driver (individual)	Driver liability, collision
Autonomous	3 Personally owned autonomous	Personal autonomous vehicle insurance	Vehicle owner (individual)	Comprehensive, liability (e.g., road worthiness)
			AV system manufacturer/ OS provider (commercial)	AV product liability
Autonomous	4 Shared autonomous	Commercial autonomous vehicle insurance	Vehicle owner (commercial)	Comprehensive, liability (e.g., road worthiness)
			AV system manufacturer/ OS provider (commercial)	AV product liability

Graphic: Deloitte University Press | DUPress.com

Today's infrastructure will go through this change

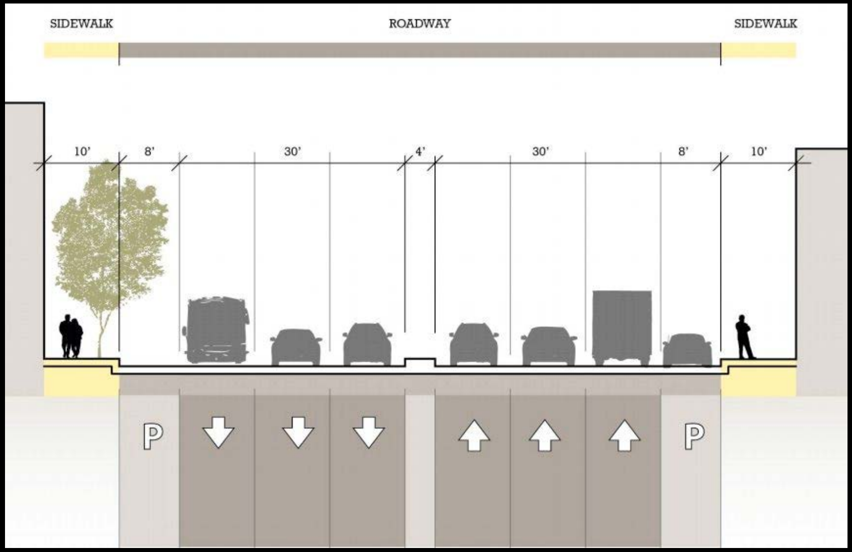


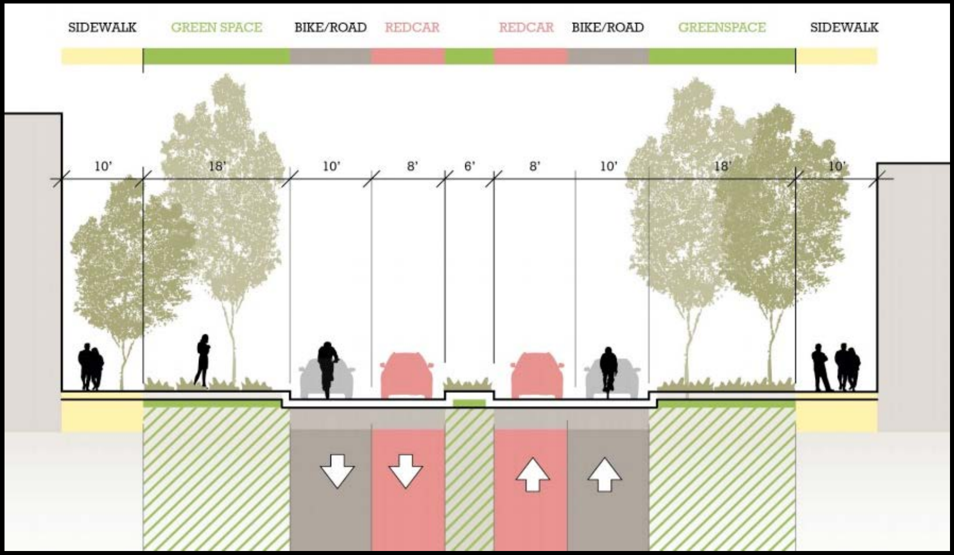
Opportunities and Challenges



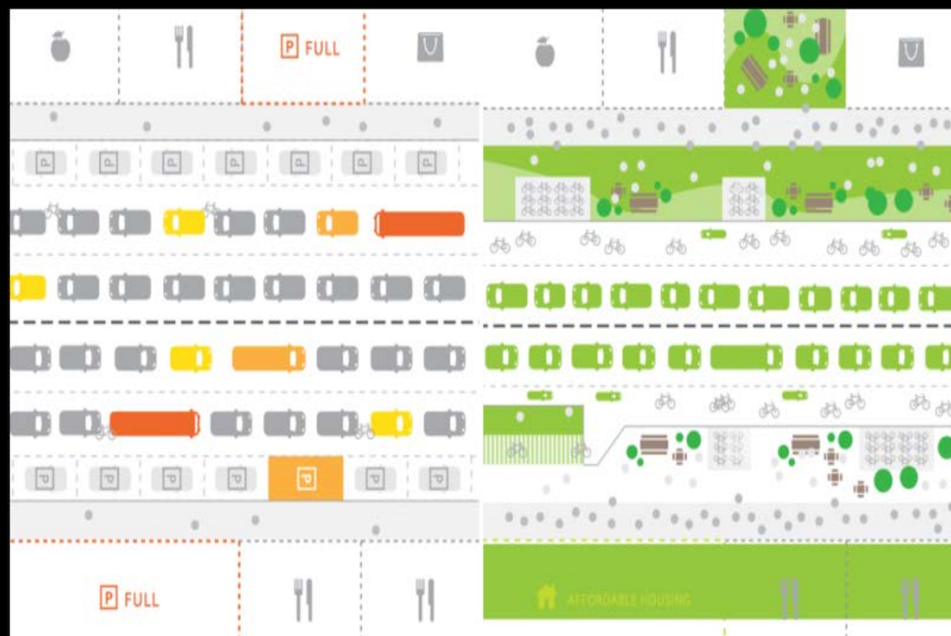
This reflects a larger value shift : sharing economy

Public rights of way will feel the change first

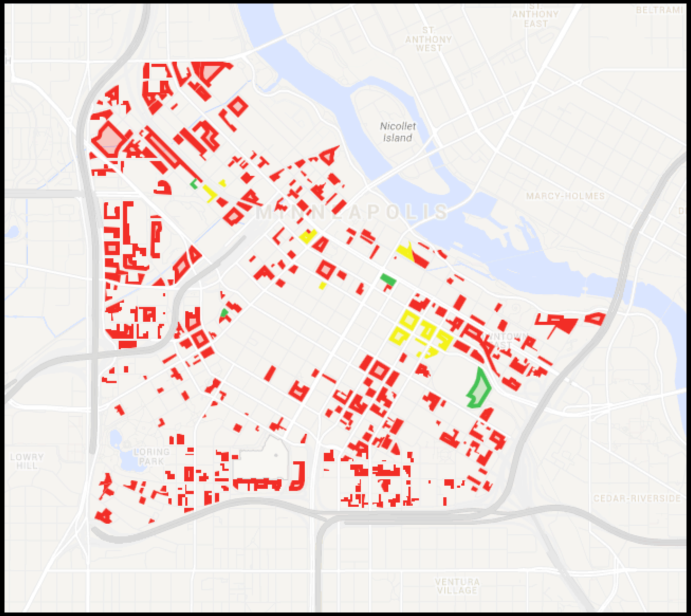




Creating a lot more space for other things

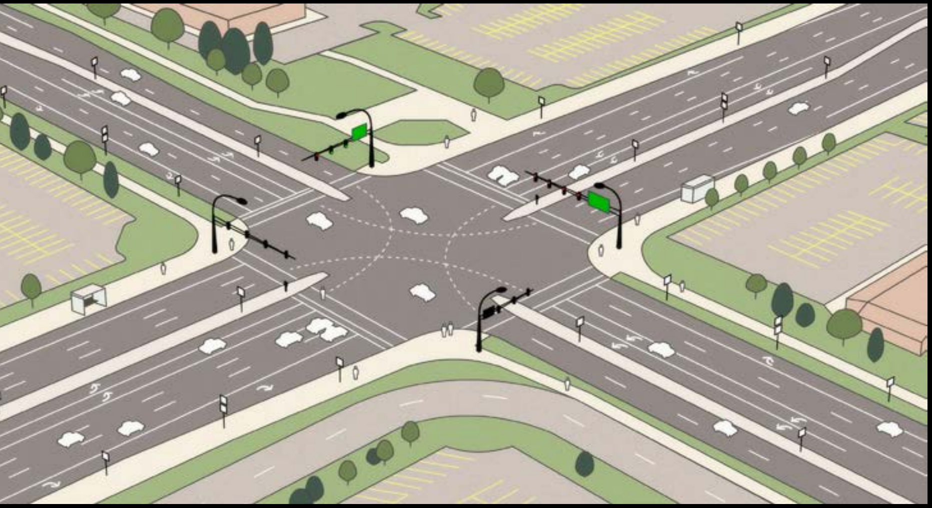


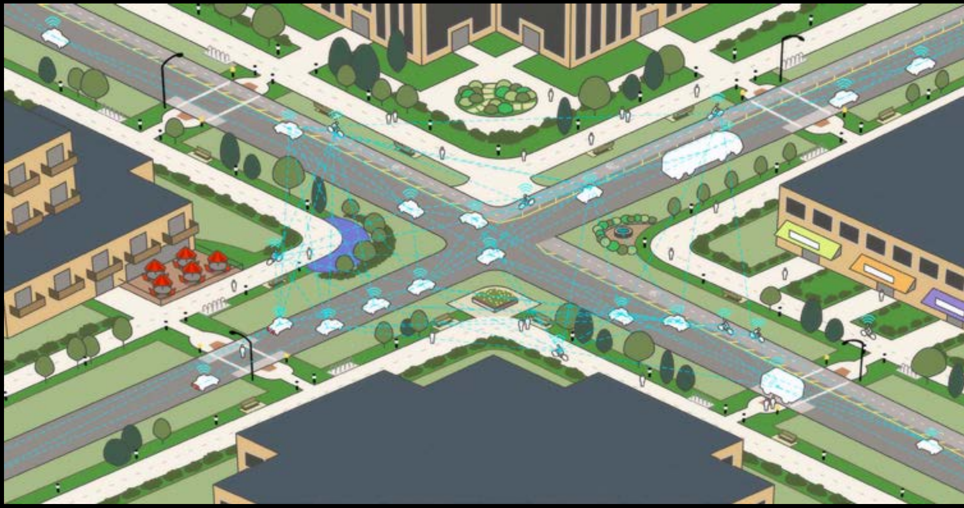
Cities will gain about 30% more land



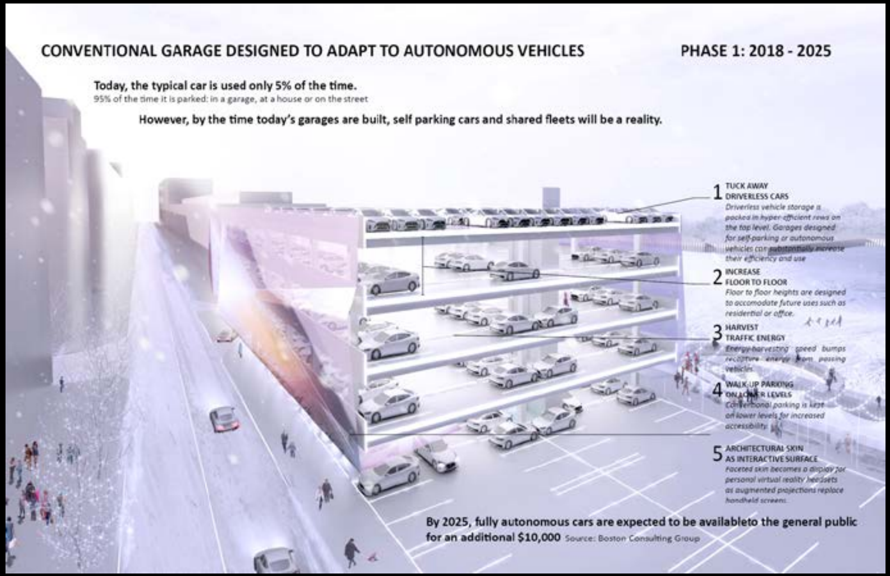
Homeowners will gain land and interior space

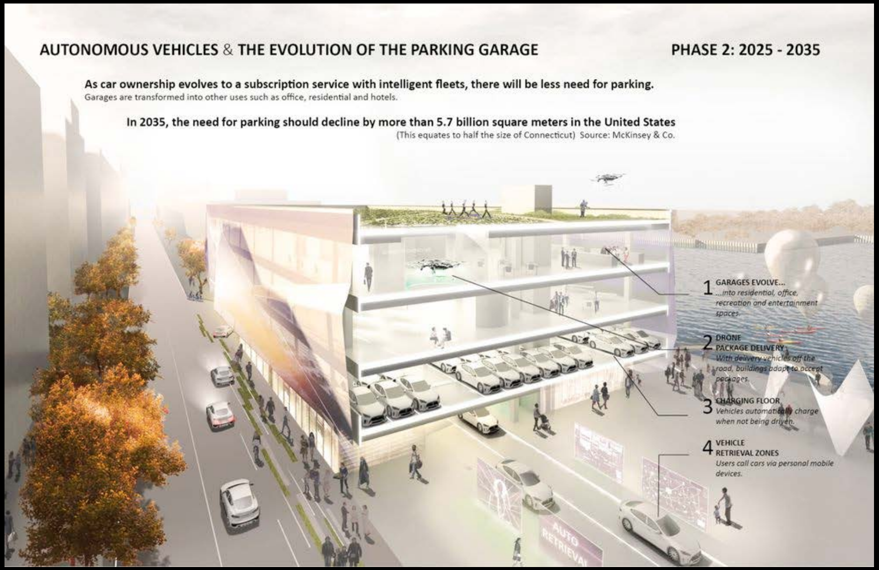
The suburban landscape will change the most





Parking ramps will have to find other uses





Highways will become multi-modal