

Agenda

Overview

Observations

1. Our World is About to Speed Up
2. The Public (and Media) Are/Will Be Very Engaged
3. Transportation Agencies Are Usually Driving, But...

Summary and Discussion

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The Technology is Just About Ready

Level	Description	Driver Roles
0 ✓	"Traditional" automated systems (cruise control, ABS, etc.)	Full control
1 ✓	Automatic braking	Must drive and monitor
2 ✓	At least two automated functions working in tandem (e.g., adaptive cruise control and lane keeping)	Must drive in most scenarios
3 ✓	Auto-pilot; driver warning	Must be ready to jump in if notified
4	Fully autonomous vehicles Autonomous taxis (even for children) Car-share systems	No driver needed – children and deliveries can ride

Source: adapted from National Highway Transportation Safety Administration

Policy and Legislation Status - US

Current Status ■ Passed ■ Under Consideration ■ Failed

Map: The Center for Internet and Society, Stanford University

Autonomous and Connected Vehicles Require Integrated Technology

- In-vehicle sensors and computers capture information
- Vehicle communicates with infrastructure (V2I), other vehicles (V2V), and the cloud (V2X)

How the Google Car Works

GPS
Position sensor

Laser scanner
Front-facing camera

Display
Kill switch

Radar
Computer

Computer: Analyzes data collected by the sensors and combines with GPS and Google Maps to locate the car's position, plot trajectory and control the vehicle.

Kill switch: Self-drive mode turns off if anyone moves the steering wheel, pedals, or pushes a big red button between the front seats.

Front-facing camera: Helps detect road signs, traffic cones and the color of traffic lights.

Radial view: 64 laser beams spinning rapidly generate a 360-degree view of the surrounding environment, including pedestrians and other objects.

An object in motion: The car's reaction to objects depends largely on the object's size and pattern of movement.

Tricky when wet: Sensors currently are unable to detect lane markings when snow or rain is present.

Off the grid: Cannot self-drive on a road or area not yet mapped.

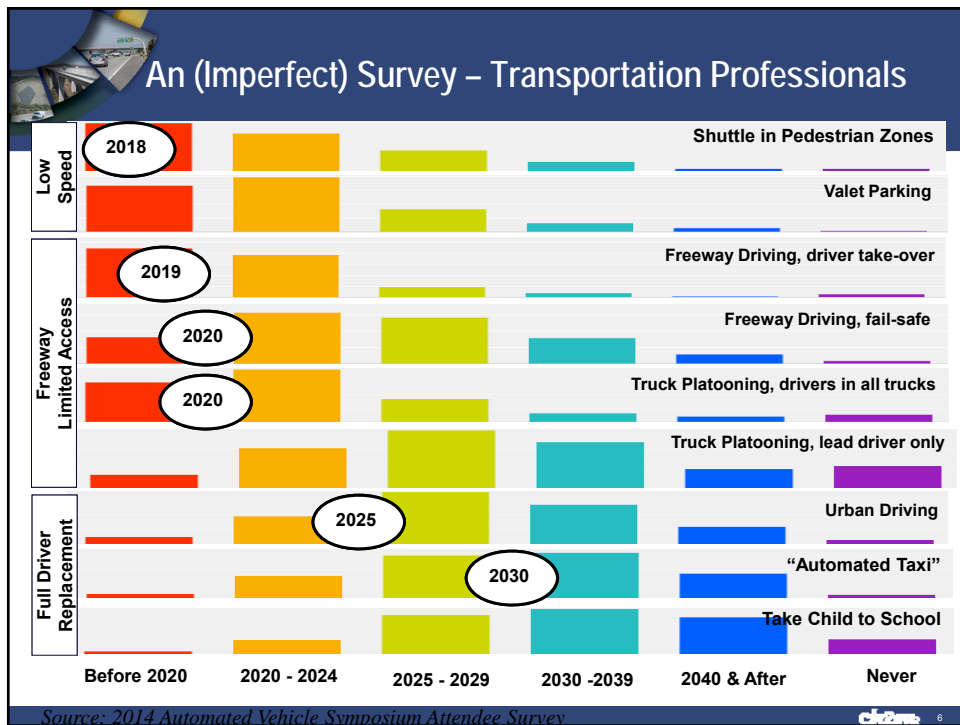
Within the law: Self-drive mode is programmed to obey traffic laws, including the recommended space between vehicles.

No parking allowed: System cannot yet park the car on its own.

Source: Google, Christopher Kaiser/The Wall Street Journal

Google is developing self-driving technology that combines data collected by sensors installed on a car with existing mapping software to speed up, brake and steer to a destination. The company expects the system will be ready for consumers within five years.

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Will Autonomous Vehicles Follow Other Vehicle Technology Deployment Patterns (GPS, Airbags)?

Or Will Autonomous Vehicle Adoption Grow Exponentially? It will sneak up!!!

LILLY PADS IN A LAKE
30 days – 100% full

- Day 1 - .0000002% - NOTHING
- Day 15 (half the month) – .003%
- Day 28 – 25%
- Day 29 – 50%
- Day 30 – FULL

It is Coming...!!





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Observation #1: Our World is About to Speed Up


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Observation: Our Basic System of Driving Isn't That Much Different After 100+ Years

Technology	1916 (plus or minus)	2016
Phones		
Computers		
Medicine		
Driving		

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Technology	1916 (plus or minus)	2016
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Observation: Our Basic System of Driving Isn't That Much Different After 100+ Years

Technology	1916 (plus or minus)	2016
Phones		
Computers		
Medicine		
Driving		

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Observation: Our Basic System of Driving Isn't That Much Different After 100+ Years

Technology	1916 (plus or minus)	2016
Phones		
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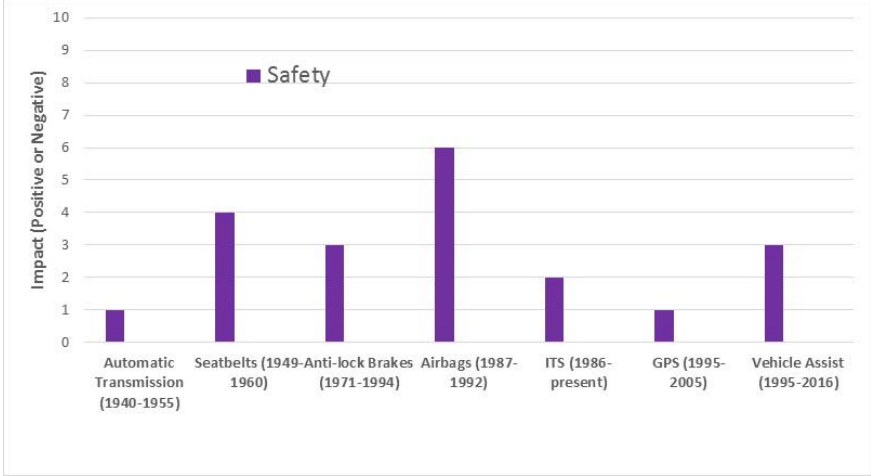
We Have Tweaked the System to Improve Operations

- Toll bridges: 1920s
- Ramp metering: 1960s
- HOV lanes and connectors: 1970s
- Toll roads: 1990s
- Price managed (Express) lanes: 1990s

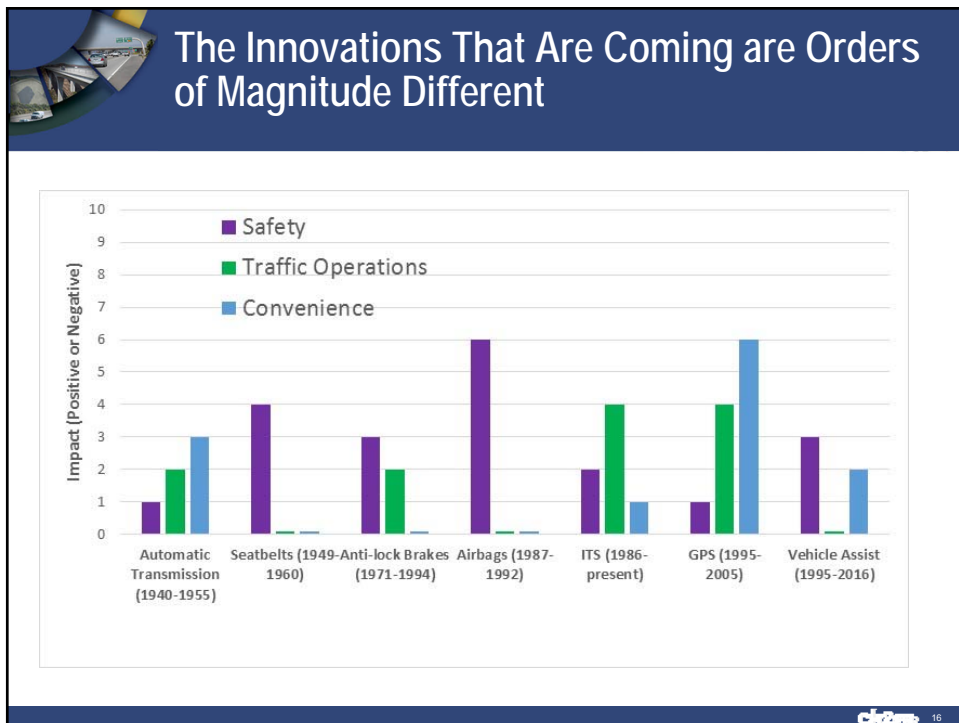
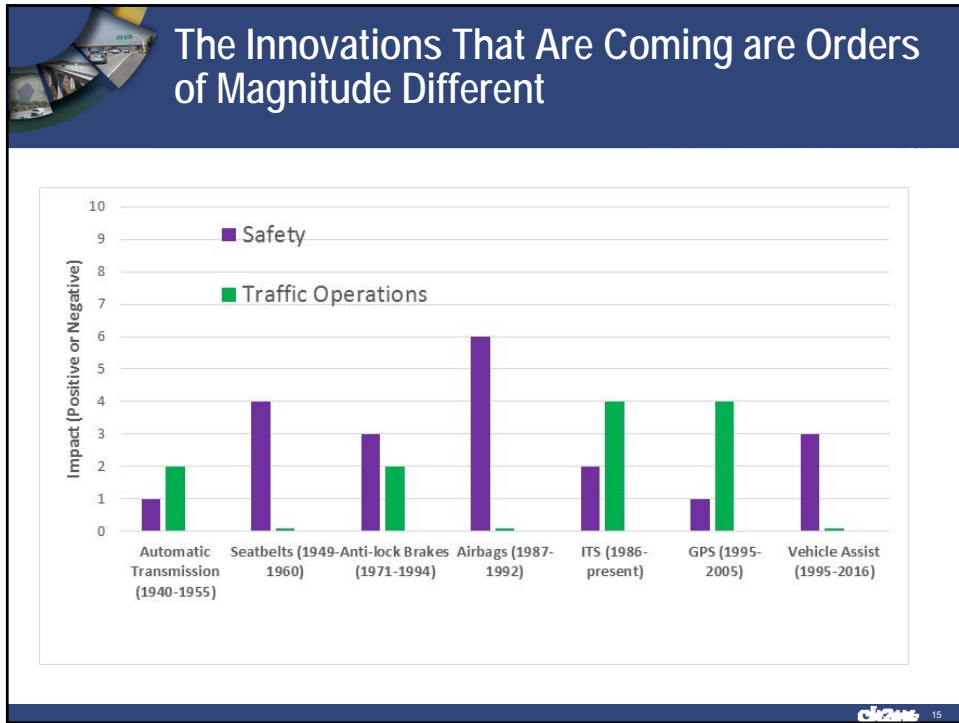
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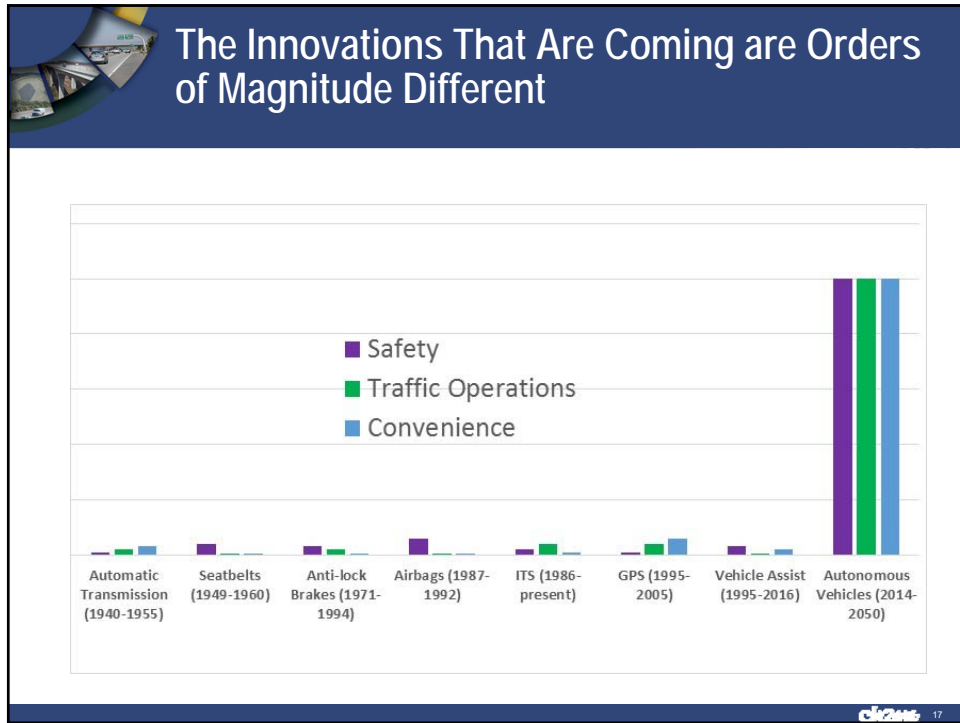
The Innovations That Are Coming are Orders of Magnitude Different

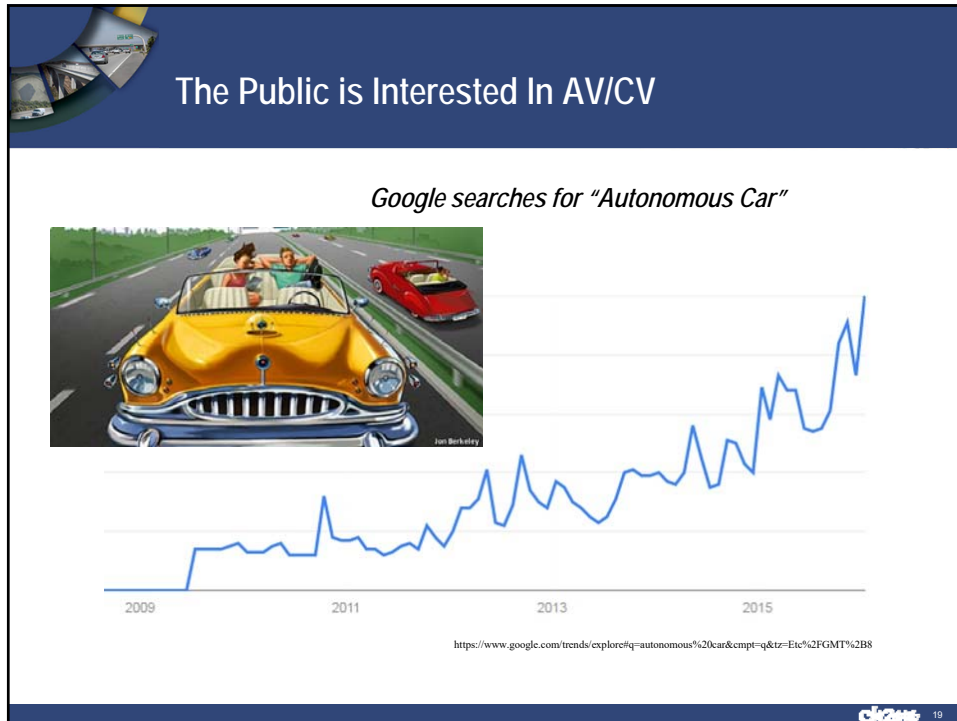


Innovation	Period	Impact (Safety)
Automatic Transmission	1940-1955	1
Seatbelts	1949-1960	4
Anti-lock Brakes	1971-1994	3
Airbags	1987-1992	6
ITS	1986-present	2
GPS	1995-2005	1
Vehicle Assist	1995-2016	3

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- ## Anticipated Benefits of Autonomous/Connected Vehicles
- Productive and happy ex-drivers (quality of life)
 - Accident reduction
 - Increased capacity and reduced travel times
 - Reduced need for parking
 - New transportation options:
 - "Mazda: drop me downtown and then go wait until I call you"
 - "Mazda: pick up the kids from school so I don't have to leave work early"
 - "Mazda: I left my phone at home – go pick it up and bring it back to me"
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Public Interests (Or Media Perception of Public Concerns)


- Safety
- Legal Challenges
- Ethics
- Terrorism/Hackers
- Congestion/Induced Demand
- Privacy
- Equity/Mobility
- When?
- Insurance
- Cost
- Rules
- Loss of Driving Skills

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Public Interests (Or Media Perception of Public Concerns)

Autonomous Scenario A – Replacement in-kind?

- Safety
- Legal Challenges
- Ethics
- Terrorism/Hackers
- Congestion/Induced Demand
- Privacy
- Equity
- Insurance
- When?
- Cost
- Rules
- Loss of Driving Skills



http://core0.staticworld.net/images/article/2015/01/slide_urban-100564880-primary.idge.jpg

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Public Interests (Or Media Perception of Public Concerns)

Autonomous Scenario B – Technology-Driven Shared Vehicle Utopia?

- Safety
- Legal Challenges
- Ethics
- Terrorism/Hackers
- Congestion/Induced Demand
- Privacy
- Equity
- Insurance
- When?
- Cost
- Rules
- Loss of Driving Skills

ADAPTIVE FLOW
MANAGING THE INTERMODAL FUTURE OF URBAN MOBILITY

TRAFFIC LIGHT
Audi Traffic Light System - Uses infrastructure with traffic lights

BIKE
Safe and quiet ride through city

PEOPLE / SMARTPHONE
Information access to a variety of transportation

PUBLIC TRANSPORT
Active transport with all the benefits of a car

CARS
Control traffic flow with Car-to-X and Car-to-Infrastructure communication

TRAFFIC COMPUTER
Intelligent traffic control

<http://www.designboom.com/design/audi-urban-future-initiative-11-20-2015/>

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Public Interests (Or Media Perception of Public Concerns)

Autonomous Scenario C – Reality

- Safety
- Legal Challenges
- Ethics
- Terrorism/Hackers
- Congestion/Induced Demand
- Privacy
- Equity
- Insurance
- When?
- Cost
- Rules
- Loss of Driving Skills

Suburbs and Small Cities

http://core0.staticworld.net/images/article/2016/01/tumblr_inline_nzqaursectf0rsqk_1280.png.cf-100634716-large.idgde-100638067-large.idgde.jpg

Highways

http://www.cognizantperspectives.com/a/images/Perspectives/designing_for_manufacturing_fig3.jpg

Major Urban Centers

<http://www.designboom.com/design/audi-urban-future-initiative-11-20-2015/>

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Other Broad Challenges for Everyone

- Fog of media and advocacy hype
- Diffuse and gradual effects
- Liability, privacy and data security
- Unintended consequences (VMT+++ from HOV-0s)



FORTUNE

TECH

Only 6% of Cities are Preparing for Driverless Cars

Car-makers say driverless vehicles will be here by 2020, but urban planners are a much slower believer.

BY DAVID J. MERRILL 15 JULY 2015

It's a shiny, self-driving car, the National League of Cities found that only 6% of cities' current long-term transportation plans consider the potential effects of driverless car technology.

The Toyota Mirai F110 is shown in a laboratory. PHOTOGRAPH BY GREG BECKER FOR FORTUNE

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Observation #3: Transportation Agencies are Usually Driving, But...

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Transportation Agencies (Have/Will Have) Unique Concerns

1. Licensing/Insurance
2. A New Paradigm for the Safety Foundation
3. Infrastructure Requirements
4. Integration with New Partners

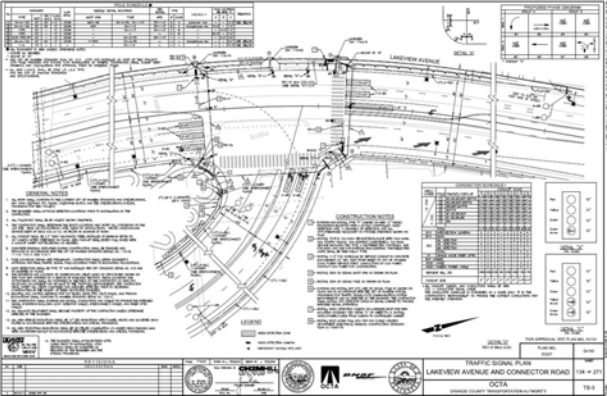


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Transportation Agency Concerns – Infrastructure Requirements

Autonomous/Connected Vehicles Will Likely Change Highway Design

- Communications Infrastructure
- Safety Treatments
 - (e.g., Crash Cushions)
- Design Standards
 - (e.g., Lane Widths)
- Lighting (More/Less?)
- Pedestrian Treatments



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Transportation Agency Concerns – Infrastructure Requirements

Autonomous/Connected Vehicle Highway Design

- Complete
- Safety
-
- Light
- Pedestrian

We need to know what type of infrastructure we need to put in place for you {industry} to be successful. (Nevada Governor Brian Sandoval, January 5, 2016).

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Transportation Agency Concerns – Integration with New Partners

Transportation Agencies Will Work With New Partners

Current:

- Other Transportation Agencies
- Contractors
- Funding Agencies
- Environmental Resource Groups
- Consultants
- AAA/trucking

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Transportation Agency Concerns – Integration with New Partners


Transportation Agencies Will Work With New Partners

Current:

- Other Transportation Agencies
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- Consultants
- AAA/trucking



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Transportation Agency Concerns – Integration with New Partners

<p>Old Partners:</p> <ul style="list-style-type: none"> ■ Other Transportation Agencies ■ Contractors ■ Funding Agencies ■ Environmental Resource Groups ■ Consultants ■ AAA/trucking 	<p>New Partners:</p> <ul style="list-style-type: none"> ■ Automakers/OEMs ■ Other Technology Firms ■ Data Providers ■ Insurance Companies ■ Private Equity?
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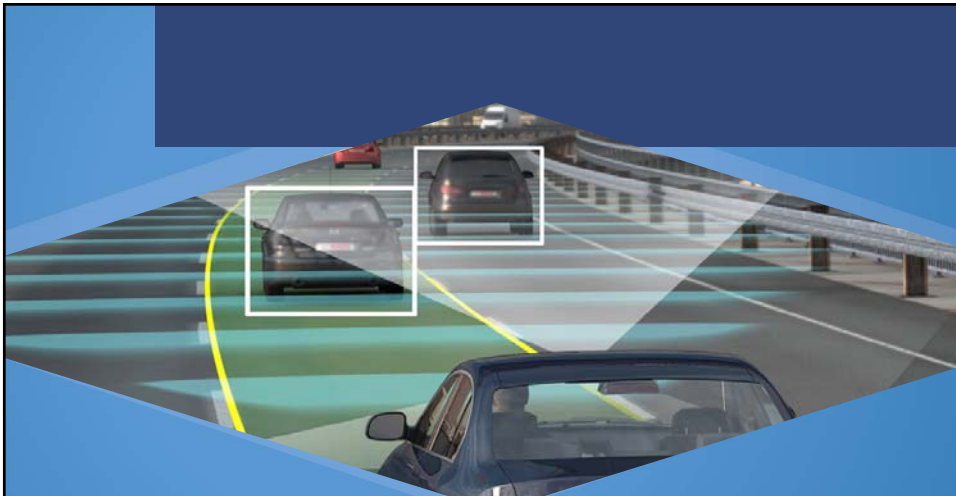
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Transportation Agency Concerns – Integration with New Partners



- Automakers/OEMs
- Other Technology Firms
- Data Providers
- Insurance Companies
- Private Equity?

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Summary and Discussion

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Takeaways



- AV/CV
 - Exciting, fast, and uncertain
 - “Exciting, fast, and uncertain” is not standard for most transportation agencies
- Bridges will be needed
 - Old business won't go away
 - New partners are coming



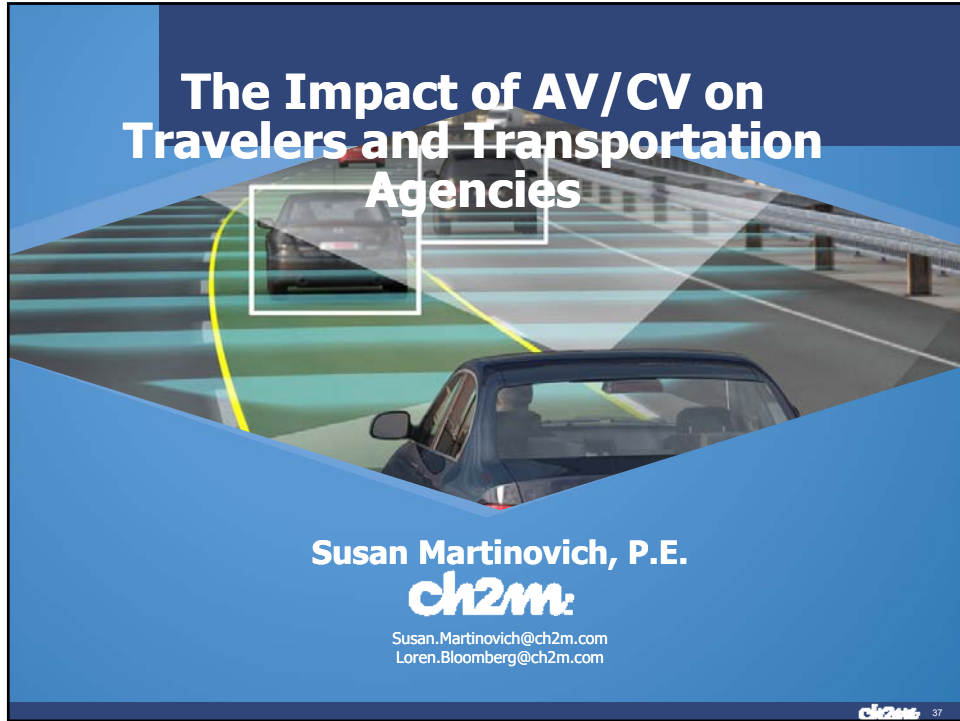

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Discussion Items

- What is exciting and what is scary?
- Where and what will you see first?
- What is your agency's role?

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The Impact of AV/CV on Travelers and Transportation Agencies

Susan Martinovich, P.E.

ch2m:

Susan.Martinovich@ch2m.com
Loren.Bloomberg@ch2m.com

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