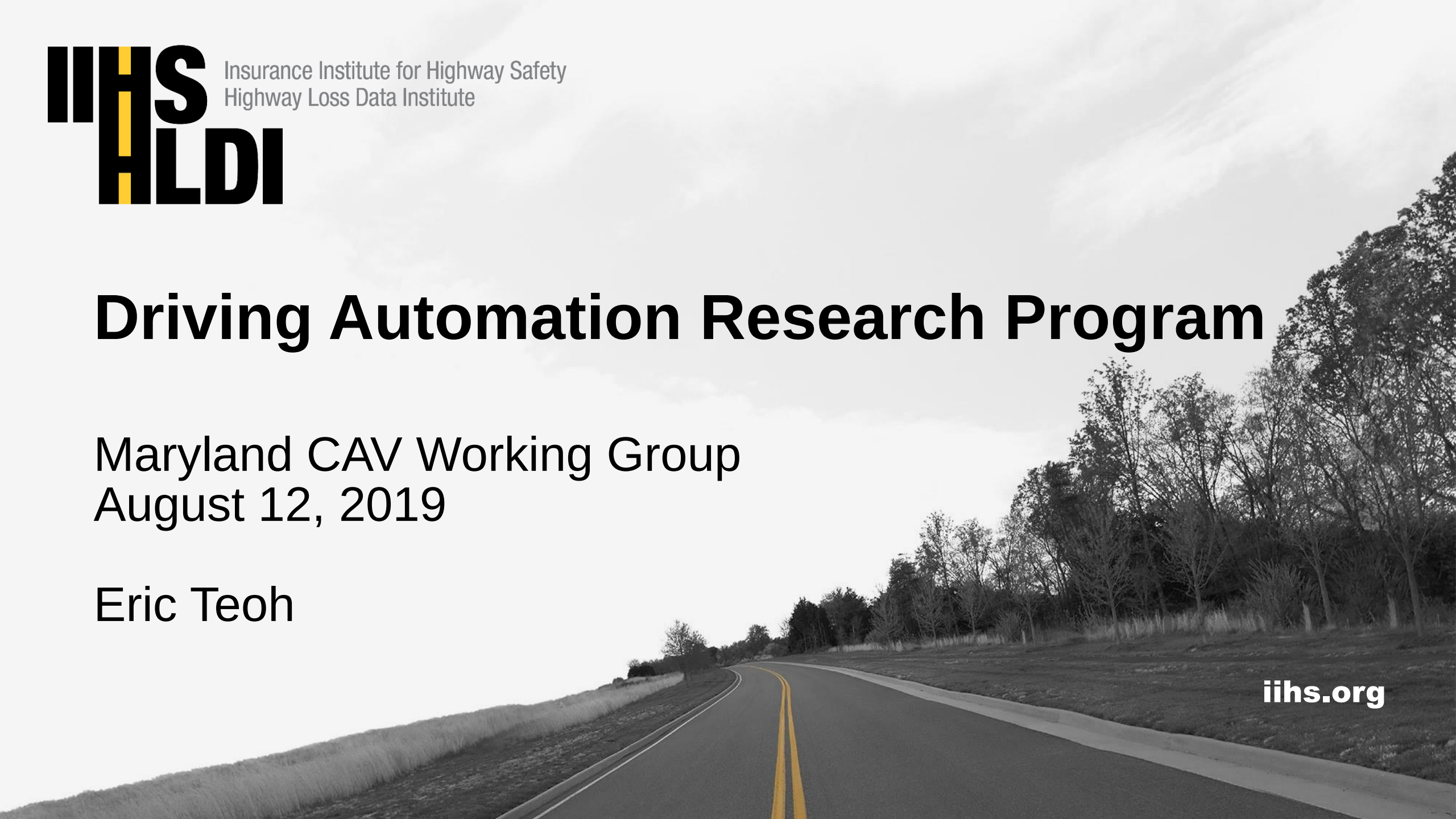
Insurance Institute for Highway Safety
Highway Loss Data Institute

Driving Automation Research Program

Maryland CAV Working Group
August 12, 2019

Eric Teoh

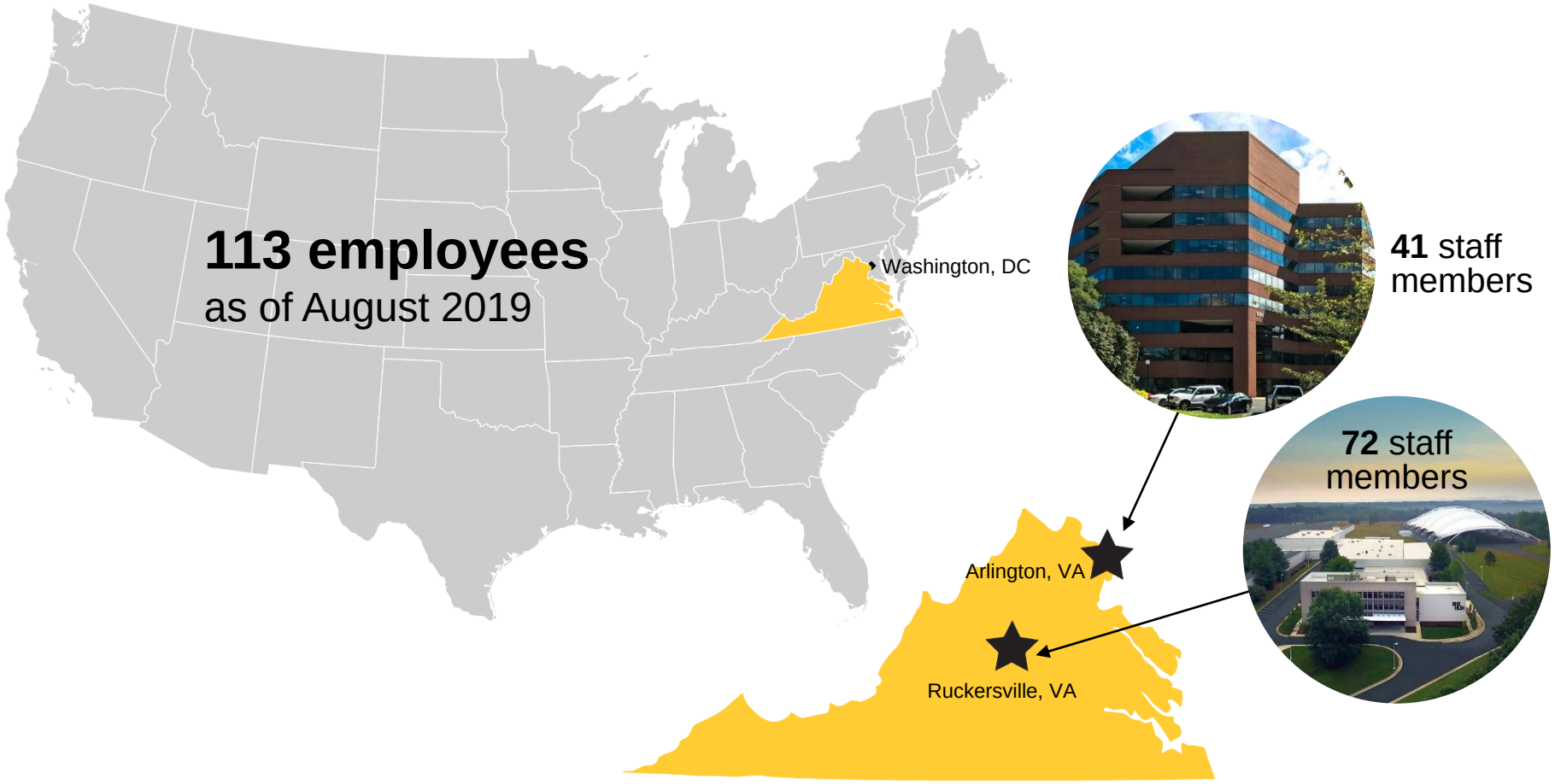


iihs.org

IIHS is an independent, nonprofit scientific and educational organization dedicated to reducing the losses — deaths, injuries and property damage — from motor vehicle crashes.

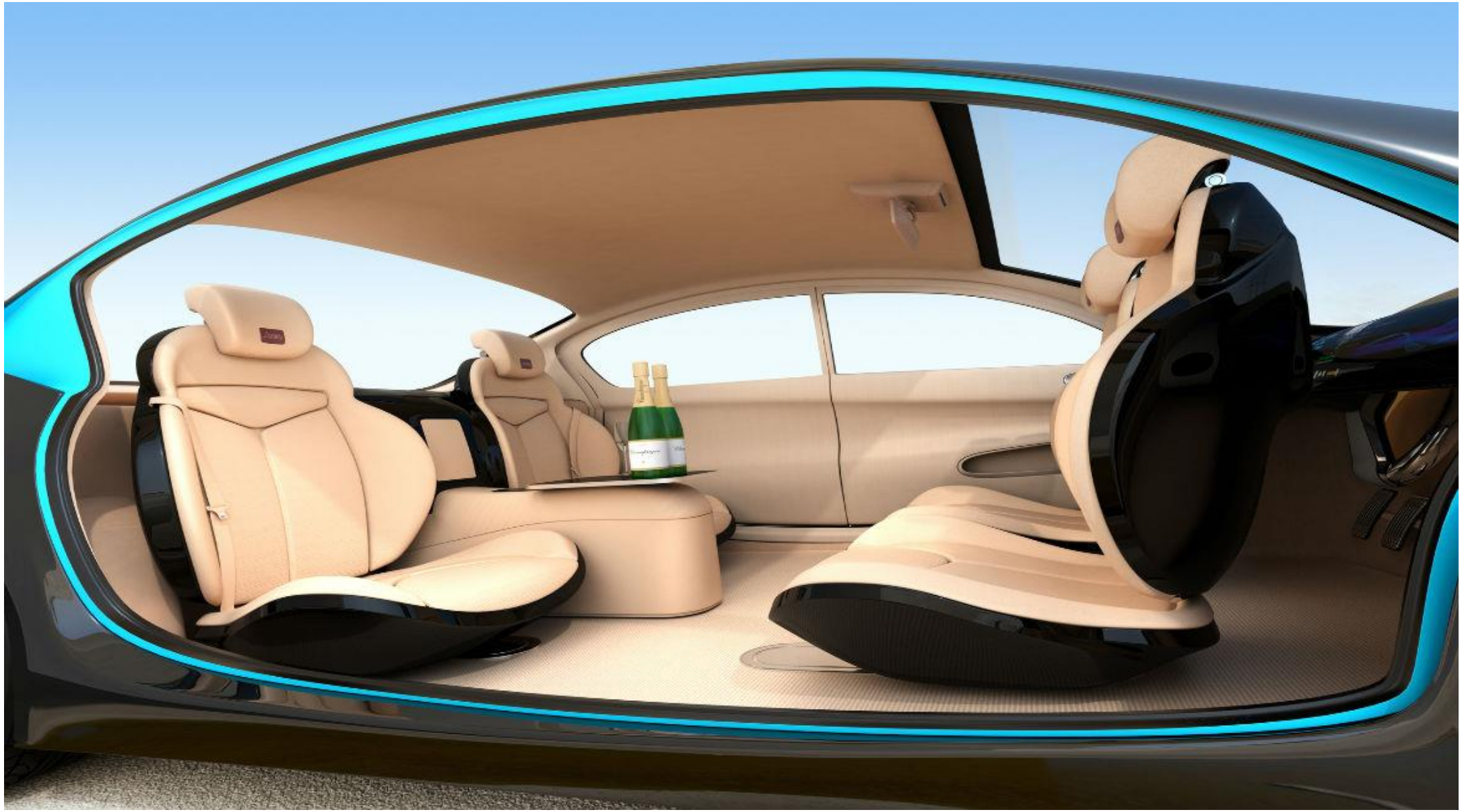
HLDI shares and supports this mission through scientific studies of insurance data representing the human and economic losses resulting from the ownership and operation of different types of vehicles and by publishing insurance loss results by vehicle make and model.

Both organizations are wholly supported by auto insurers.


113 employees
as of August 2019
Washington, DC
41 staff members
72 staff members
Arlington, VA
Ruckersville, VA

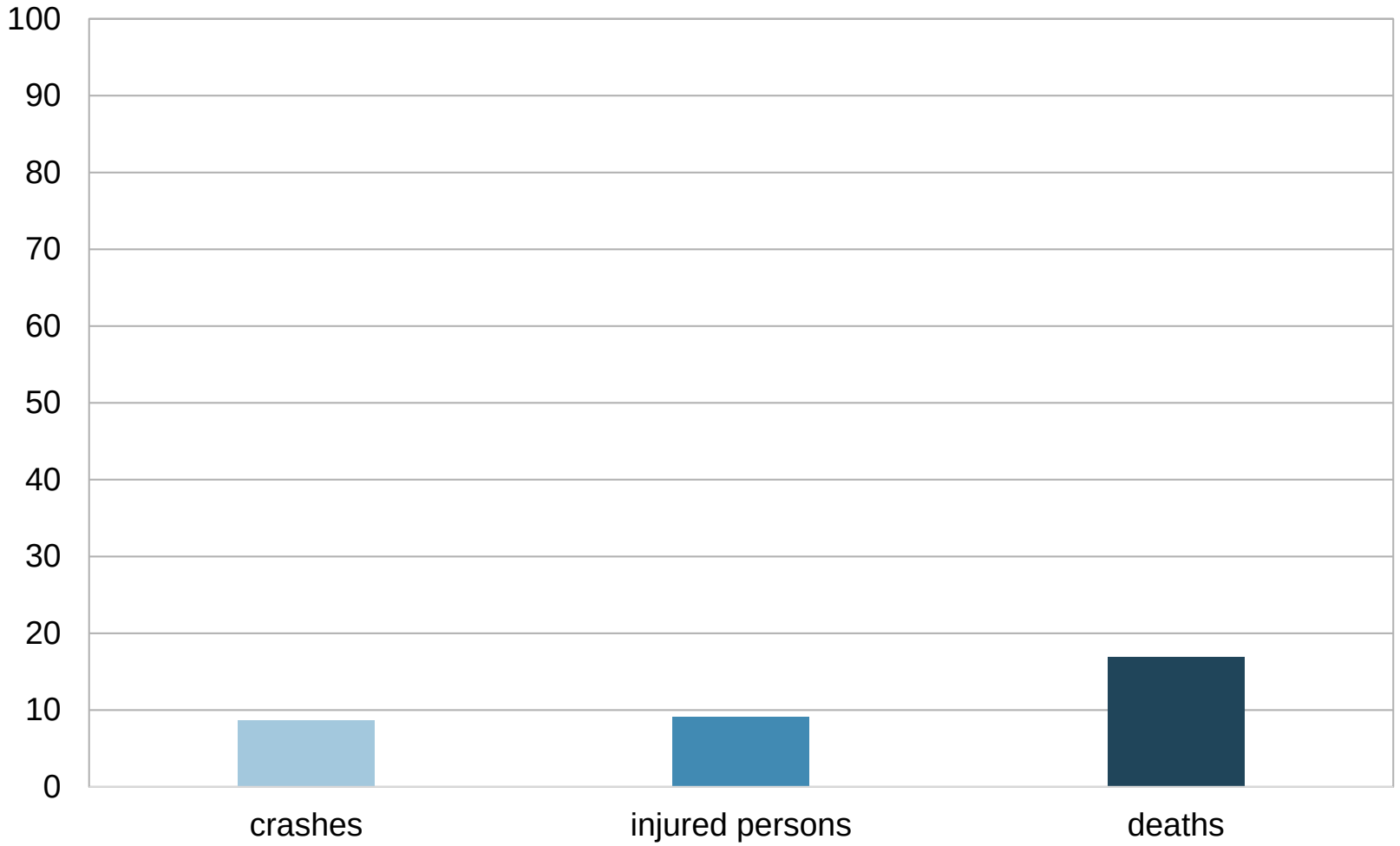
Highly-automated driving technology

Is it really this simple?



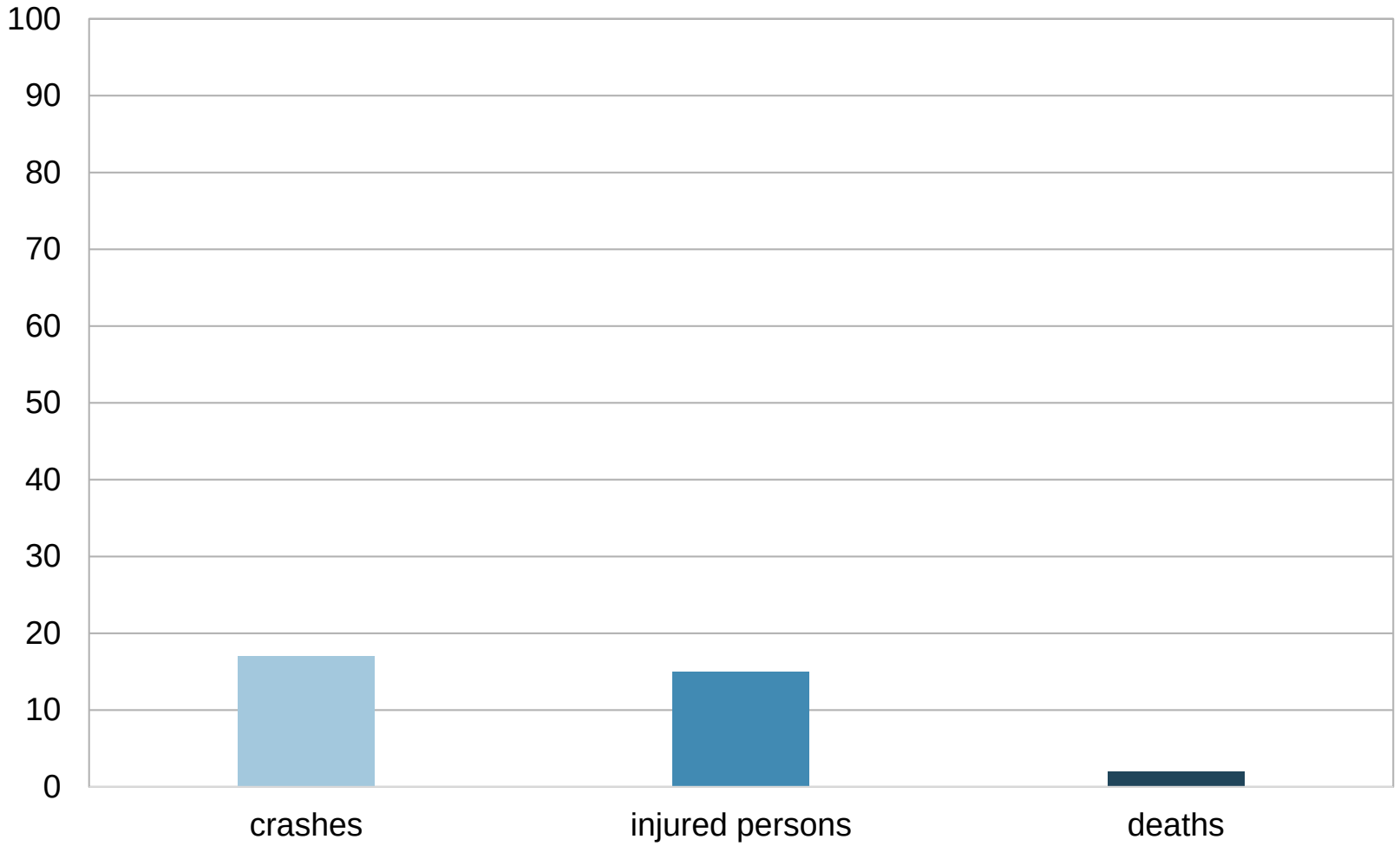
Maximum crash prevention potential if early automated driving systems are restricted to interstates and freeways

Percent on interstates and freeways, 2014



Maximum crash prevention potential if early automated driving systems are restricted to rush-hour traffic situations

Percent that are front-to-rear/sideswipe and occurred during rush-hours, 2015



Waymo: Google self-driving car test program

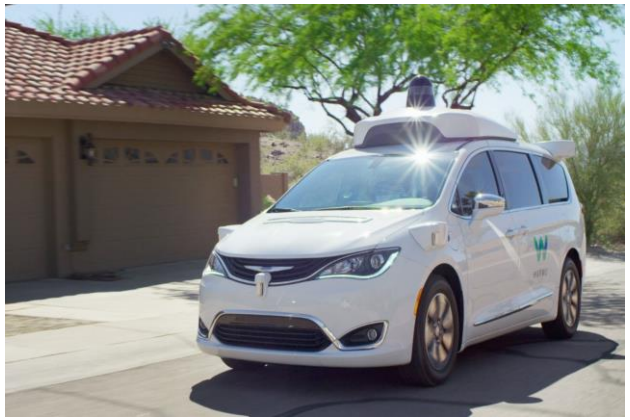
2009-present

- Supervised testing on public roads in Mountain View, CA, and later expanded to Austin, TX; Kirkland, WA; and metro Phoenix, AZ
- Involved in 1/3 as many police-reportable crashes as human drivers per mile traveled in Mountain View, CA (during 2009-15)
- Vast majority of crashes involved Google car rear-ended by another vehicle (driven by a human)
- So, even if autonomous vehicles are operated extremely safely, there will still be crashes when they are struck by other vehicles driven by humans.

modified Toyota Prius

modified Lexus RX450h

Waymo Firefly prototype low-speed vehicle

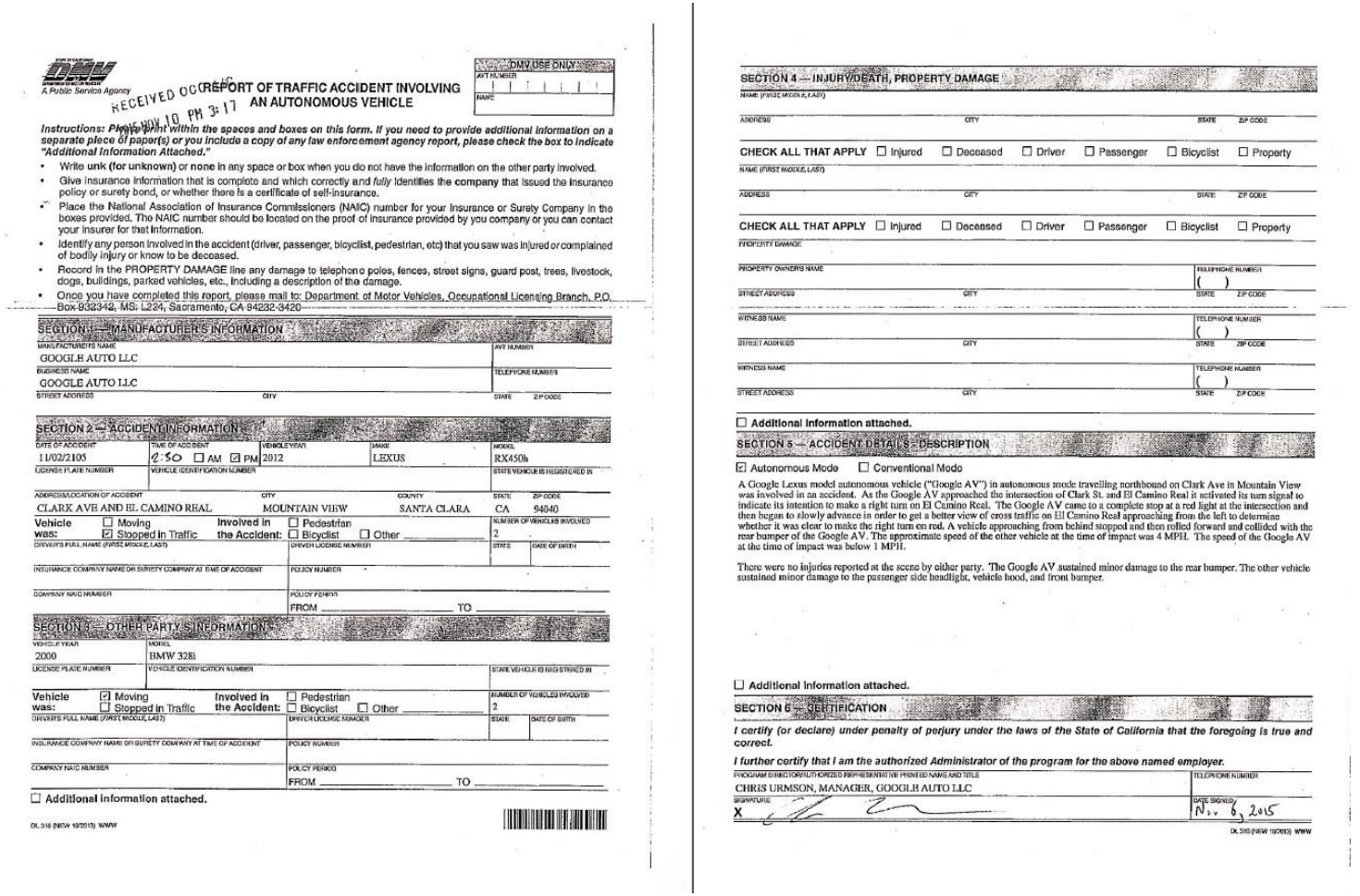


modified Chrysler Pacifica

Waymo: Google self-driving car test program

2009-present

- Since 2014, CA has required all crash involvements of AVs tested on public roads to be reported and made public (Google reported these voluntarily before that)
- In 2015-16, Waymo shifted most of its testing to Phoenix, AZ, which does not make such crash information public
- Reporting requirements should be developed that do not vary by state so that researchers, government, and the public can understand the safety implications of AV testing



REPORT OF TRAFFIC ACCIDENT INVOLVING AN AUTONOMOUS VEHICLE

RECEIVED OCT 10 PM 3:17

DMV USE ONLY

SECTION 1 — MANUFACTURER'S INFORMATION

MANUFACTURER'S NAME: GOOGLE AUTO LLC

BUSINESS NAME: GOOGLE AUTO LLC

SECTION 2 — ACCIDENT INFORMATION

DATE OF ACCIDENT: 11/02/2105 | TIME OF ACCIDENT: 2:30 ☐ AM ☑ PM | VEHICLE YEAR: 2012 | MAKE: LEXUS | MODEL: RX450h

ADDRESS/LOCATION OF ACCIDENT: CLARK AVE AND EL CAMINO REAL | CITY: MOUNTAIN VIEW | COUNTY: SANTA CLARA | STATE: CA | ZIP CODE: 94040

Vehicle was: ☐ Moving ☑ Stopped in Traffic | Involved in the Accident: ☐ Pedestrian ☐ Bicyclist ☐ Other

NUMBER OF VEHICLES INVOLVED: 2

SECTION 3 — OTHER PARTY'S INFORMATION

VEHICLE YEAR: 2000 | MODEL: BMW 328i

Vehicle was: ☑ Moving ☐ Stopped in Traffic | Involved in the Accident: ☐ Pedestrian ☐ Bicyclist ☐ Other

NUMBER OF VEHICLES INVOLVED: 2

☐ Additional information attached.

SECTION 4 — INJURY/DEATH, PROPERTY DAMAGE

CHECK ALL THAT APPLY ☐ Injured ☐ Deceased ☐ Driver ☐ Passenger ☐ Bicyclist ☐ Property

CHECK ALL THAT APPLY ☐ Injured ☐ Deceased ☐ Driver ☐ Passenger ☐ Bicyclist ☐ Property

☐ Additional information attached.

SECTION 5 — ACCIDENT DETAILS / DESCRIPTION

☑ Autonomous Mode ☐ Conventional Mode

A Google Lexus model autonomous vehicle ("Google AV") in autonomous mode travelling northbound on Clark Ave in Mountain View was involved in an accident. As the Google AV approached the intersection of Clark St. and El Camino Real it activated its turn signal to indicate its intention to make a right turn on El Camino Real. The Google AV came to a complete stop at a red light at the intersection and then began to slowly advance in order to get a better view of cross traffic on El Camino Real approaching from the left to determine whether it was clear to make the right turn on red. A vehicle approaching from behind stopped and then rolled forward and collided with the rear bumper of the Google AV. The approximate speed of the other vehicle at the time of impact was 4 MPH. The speed of the Google AV at the time of impact was below 1 MPH.

There were no injuries reported at the scene by either party. The Google AV sustained minor damage to the rear bumper. The other vehicle sustained minor damage to the passenger side headlight, vehicle hood, and front bumper.

☐ Additional information attached.

SECTION 6 — CERTIFICATION

I certify (or declare) under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

I further certify that I am the authorized Administrator of the program for the above named employer.

PROGRAM DIRECTOR/AUTHORIZED REPRESENTATIVE PRINTED NAME AND TITLE: CHRIS URMSON, MANAGER, GOOGLE AUTO LLC

SIGNATURE: X | DATE SIGNED: Nov 6, 2015

CA OL316 form: 11/02/2015 Google car crash (it got rear-ended)

Lower levels of driving automation technology

IIHS/HLDI research goals

SAE Level 2 – partial driving automation

- Evaluate real-world effects on claims, crashes, injuries, deaths
- Understand how, where, when drivers use L2
- Understand L2 design/performance characteristics, and how these influence drivers
- Develop guidelines for safe implementation

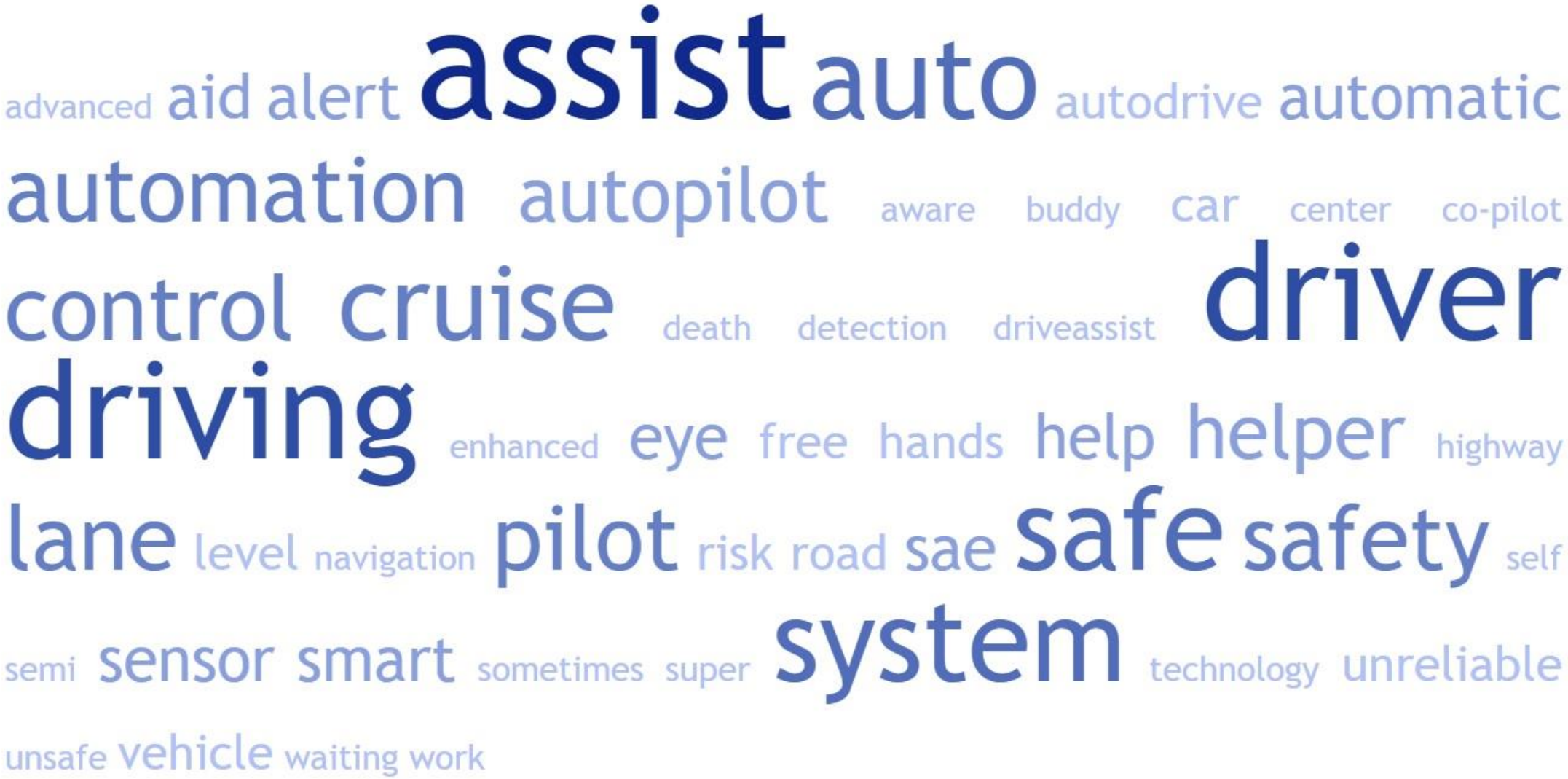
What's in a name? A national survey

Likelihood drivers consider behaviors safe while operating L2, based only on system name

	Autopilot (n=800)	Traffic Jam Assist (n=801)	Super Cruise (n=802)	Driving Assistant Plus (n=805)	ProPilot Assist (n=802)
Talking with a passenger	68%	61%	64%	65%	60%
Adjusting the stereo	58%	50%	54%	54%	55%
Foot not near the pedals	37%	25%	37%	25%	30%
Hands off the steering wheel	48%	21%	27%	27%	33%
Looking at scenery	36%	25%	29%	31%	32%
Talking on a cellphone	34%	22%	26%	27%	26%
Texting	16%	9%	9%	10%	9%
Reading a book/magazine/newspaper	8%	4%	3%	4%	3%
Watching a video/movie on a cellphone/device	8%	3%	4%	4%	4%
Using a laptop/tablet computer	7%	3%	3%	4%	4%
Taking a nap	6%	3%	3%	3%	3%

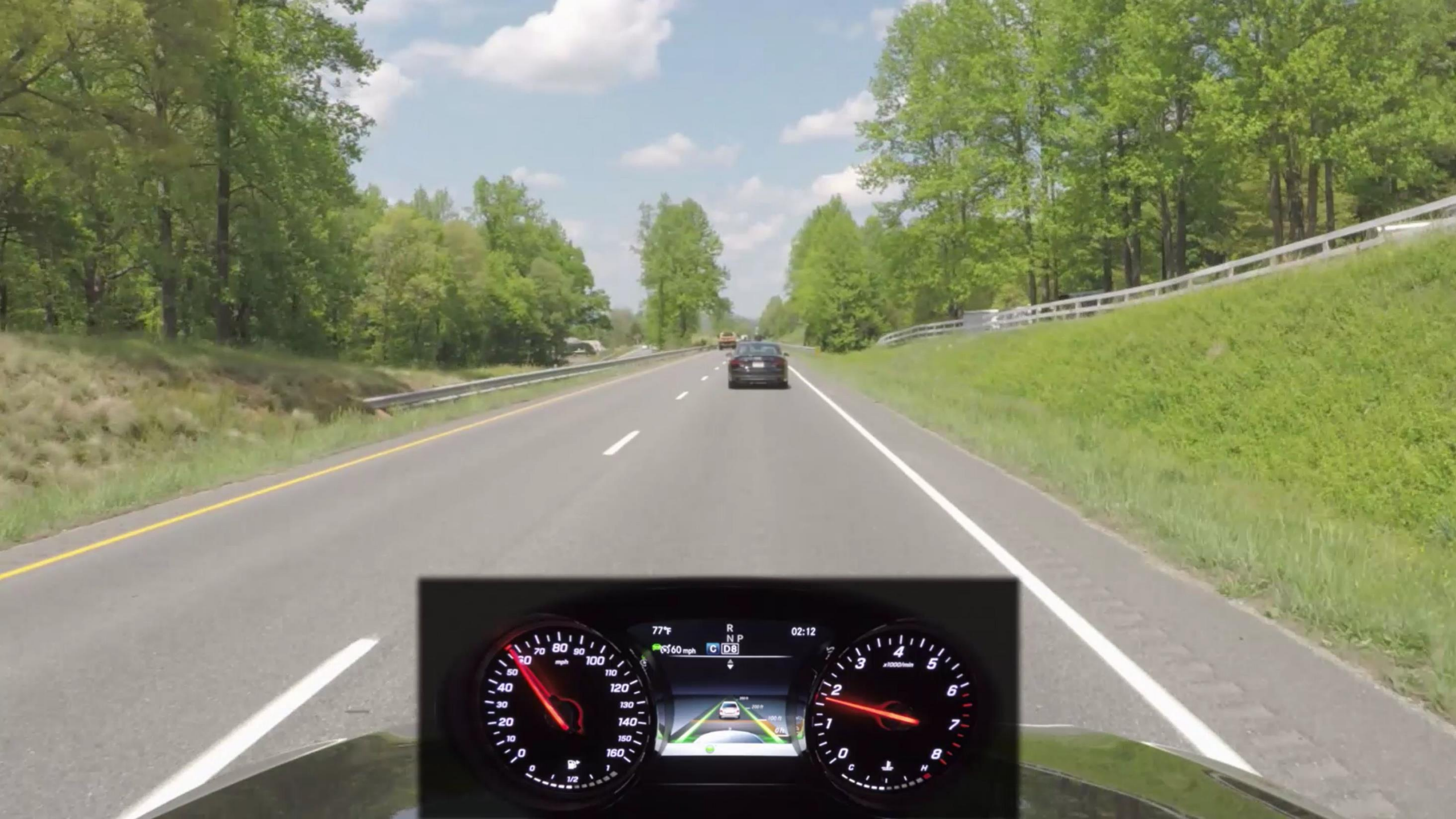
What's in a name? A national survey

Top-50 words used when respondents were asked to name an L2 system after they were given an accurate description of current L2 functionality (larger words were more frequent)



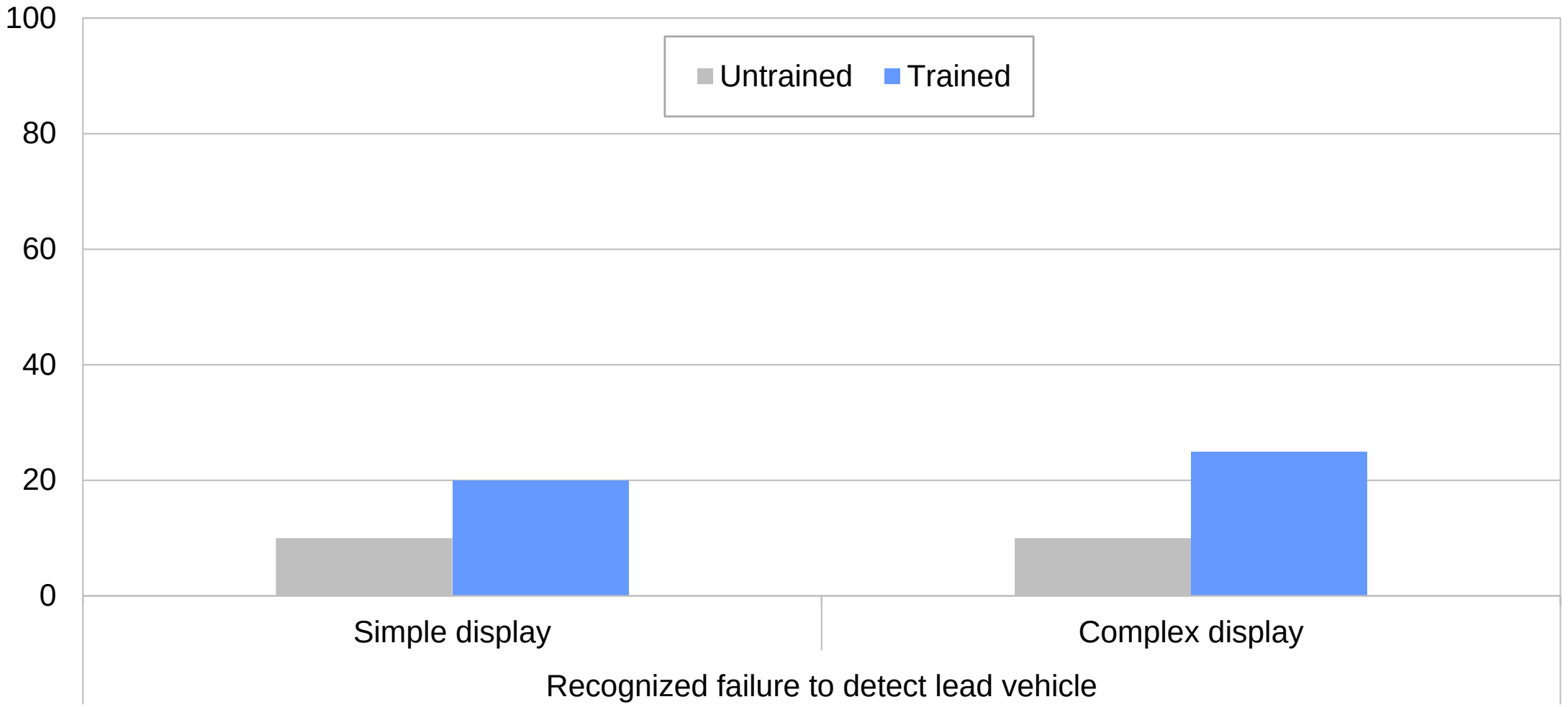
Does interface content or training matter?

Simple display condition


77°F
R
N P
02:12
60 mph
C D8
mph
x1000/min

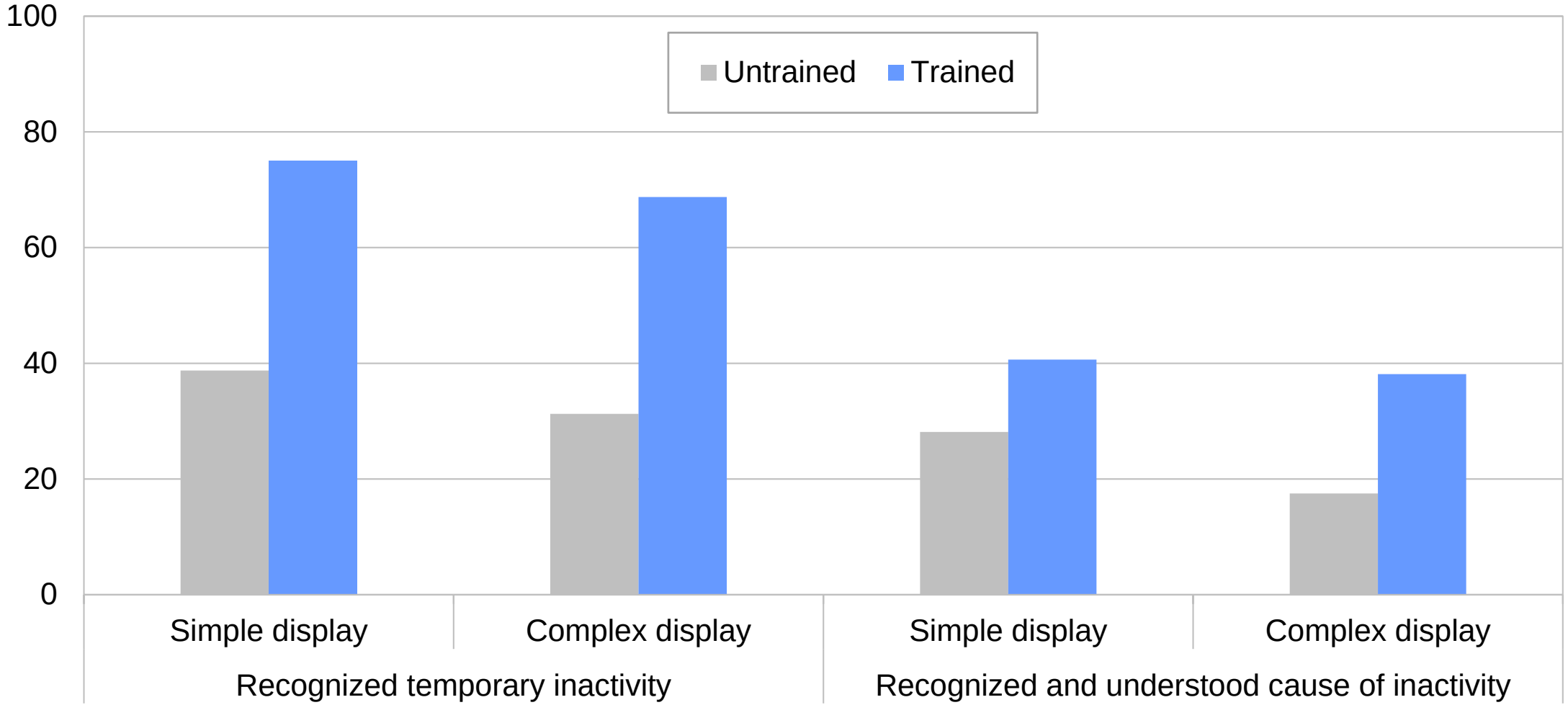
ACC limitations were poorly recognized

Status identification accuracy (percent)



Training improves lane centering activity recognition and comprehension

Status identification and comprehension accuracy (percent)



IIHS/HLDI driver experience program

ACC, lane centering, L2

- Employees used one or more vehicles for personal use or predefined routes, and then completed surveys
- Conducted in three phases during 2016-18
- Measured trust, ease of use, comprehension of displays, whether systems improved the driving task, and perceived functionality
- Catalyzed functional performance testing of L2 components: ACC and lane centering

2016 Honda Civic

2016 Infiniti QX60

2016 Toyota Prius

2016 Tesla Model S

2017 Mercedes E-Class

2017 Audi A4

2017 Audi Q7

2017 BMW 5 series

2019 Infiniti QX50

2018 Volvo S90

Vehicles and systems in IIHS functional performance testing

2016 Tesla Model S with Autopilot software ver. 7.1

2017 BMW 5 series with Driving Assistant Plus

2017 Mercedes E-Class with Drive Pilot

2018 Volvo S90 with Pilot Assist

2018 Tesla Model 3 with Autopilot software ver. 8.1

Test track – ACC

Approaching stationary target

On-road testing – ACC

Approaching stationary vehicles was more challenging than test track's ideal conditions

On-road testing – lane centering

Adding or dropping lanes created lane keeping issues

On-road testing – lane centering

Curves often were challenging

On-road testing – lane centering

Hills also were challenging

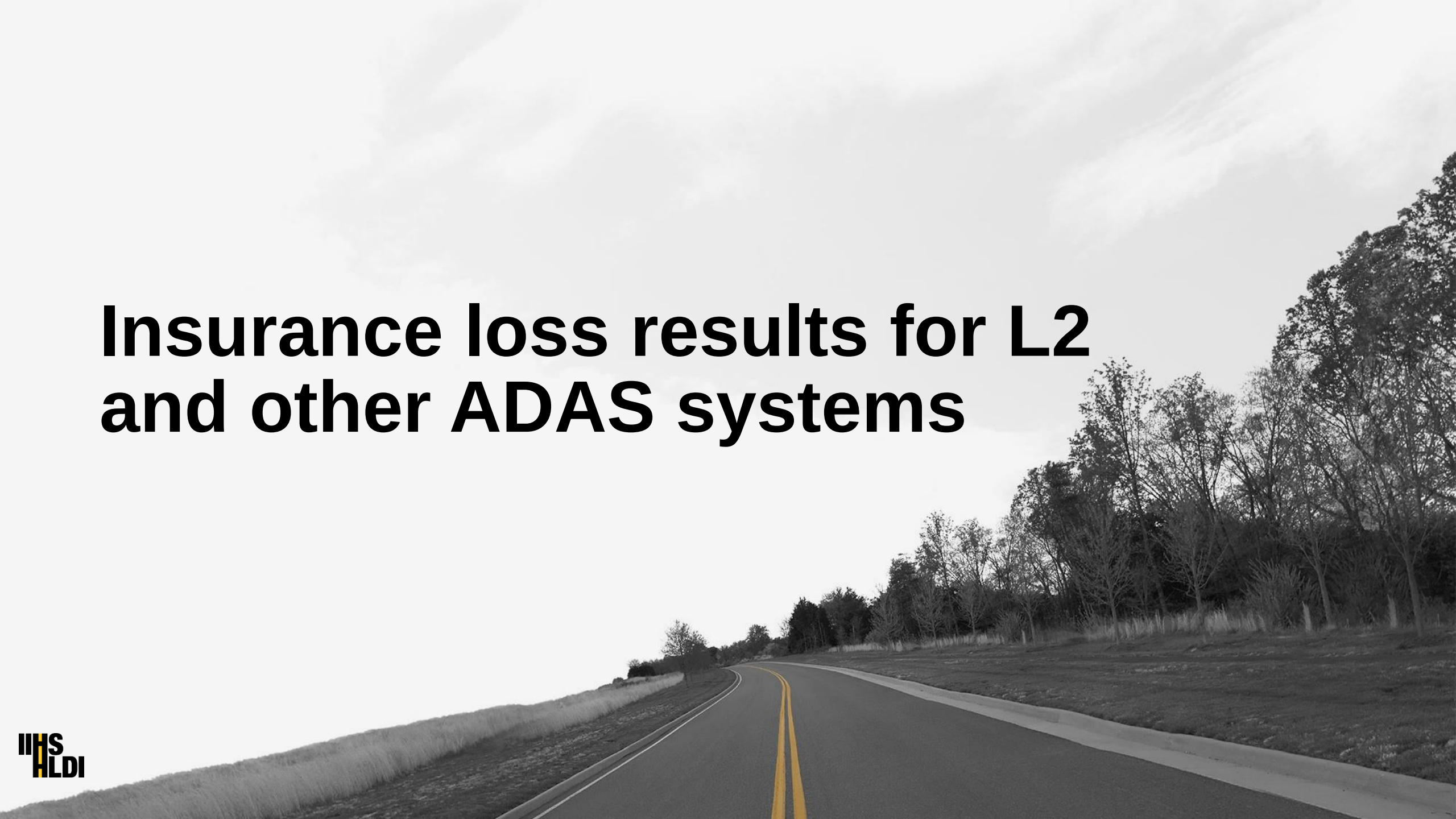
AVT Consortium overview

- Founded in Fall 2015 by Bryan Reimer, MIT AgeLab
- IIHS joined summer 2018
- Current members: Agero, Aptiv, Jaguar Land Rover, Veoneer, Toyota, Consumer Reports, Progressive, Insurance Institute for Highway Safety, Google, JD Power, TravelCenters of America, Volvo Cars
- Collect and analyze data that characterizes behavioral and safety benefits of in-vehicle technology under real use conditions
- Field operational test using MIT-owned vehicles (Range Rover, Volvo S90, Cadillac CT6) where volunteer adults drive them as their own for 1 month
- Naturalistic driving study of Tesla owners (24 vehicles total, 15 currently active)

AVT Consortium – opportunities to improve our understanding

- L2 and ACC use as a proportion of time and miles driven
  - How do these vary by roadway function class?
  - Variation by vehicle/system/person
- Drivers taking control back from L2
  - How often? For what reasons? In what situations?
- Drivers' distracting behaviors and where they're looking while using L2

Insurance loss results for L2 and other ADAS systems



HLDI data providers insure approximately 85% of the market

21st Century Insurance

Alfa Alliance Insurance Corporation

Allstate Insurance Group

American Family Mutual Insurance

American National Family of Companies

Amica Mutual Insurance Company

Auto Club Group

Automobile Insurers Bureau of Massachusetts

Chubb & Son

COUNTRY Financial

CSAA Insurance Group

Erie Insurance Group

Esurance

Farm Bureau Financial Services

Farmers Insurance Group of Companies

Florida Farm Bureau Insurance Companies

Foremost

GEICO Corporation

Hanover Insurance Group

The Hartford

Kemper Preferred

Kentucky Farm Bureau Insurance

Liberty Mutual Insurance Company

MetLife Auto and Home

National General

Nationwide

New Jersey Manufacturers Insurance Group

PEMCO Insurance

Plymouth Rock Assurance

Progressive Corporation

Rockingham Group

Safeco Insurance Companies

SECURA Insurance

Sentry Insurance

State Farm Insurance Companies

Tennessee Farmers Mutual Insurance Company

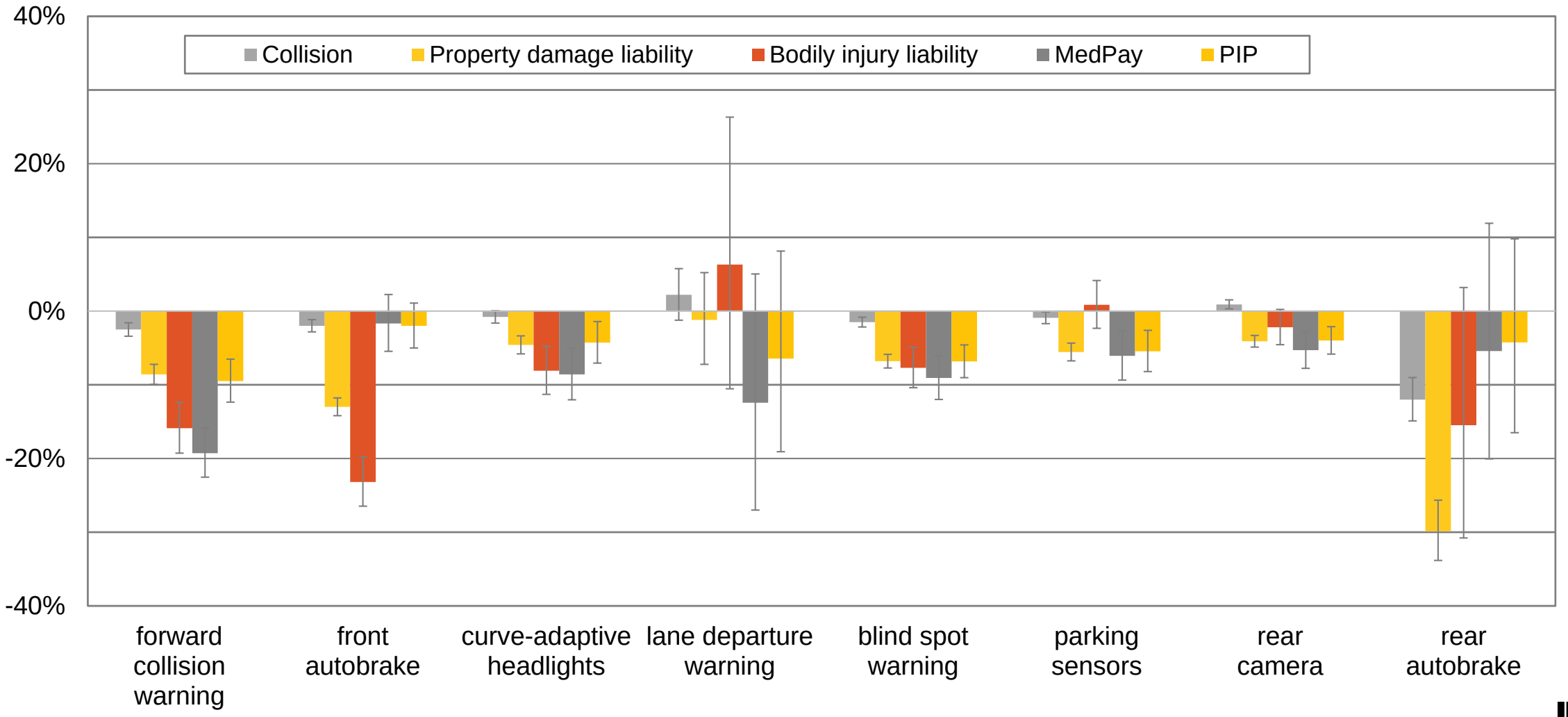
Texas Farm Bureau

The Travelers Companies, Inc.

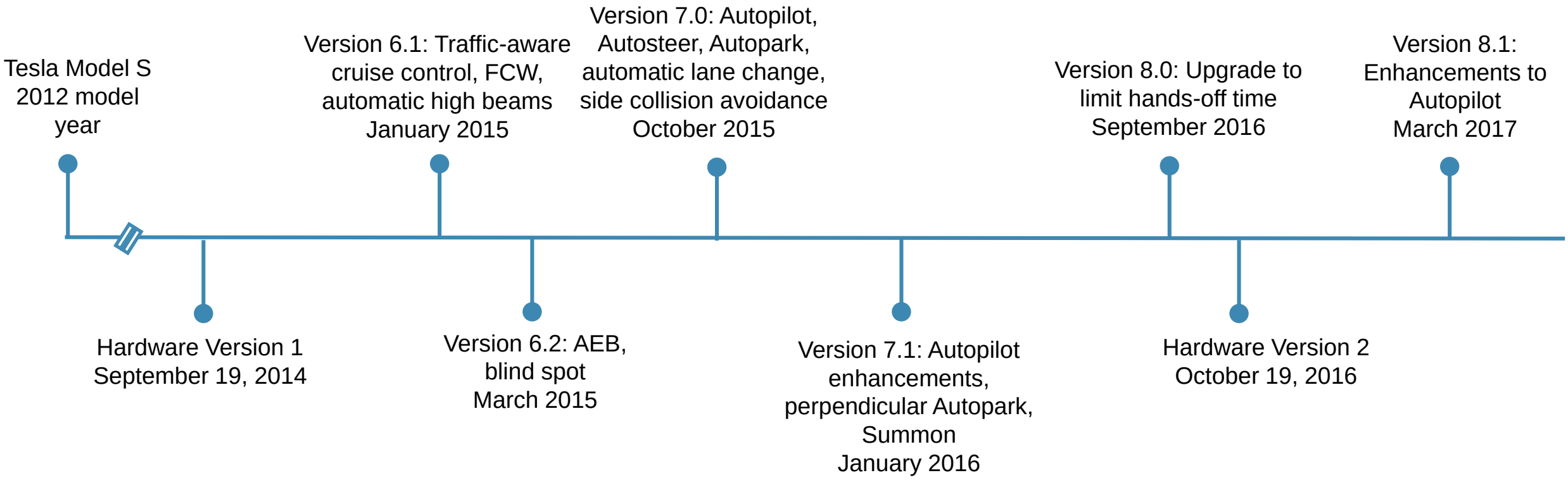
USAA

ADAS effects on claim frequency

Results pooled across automakers

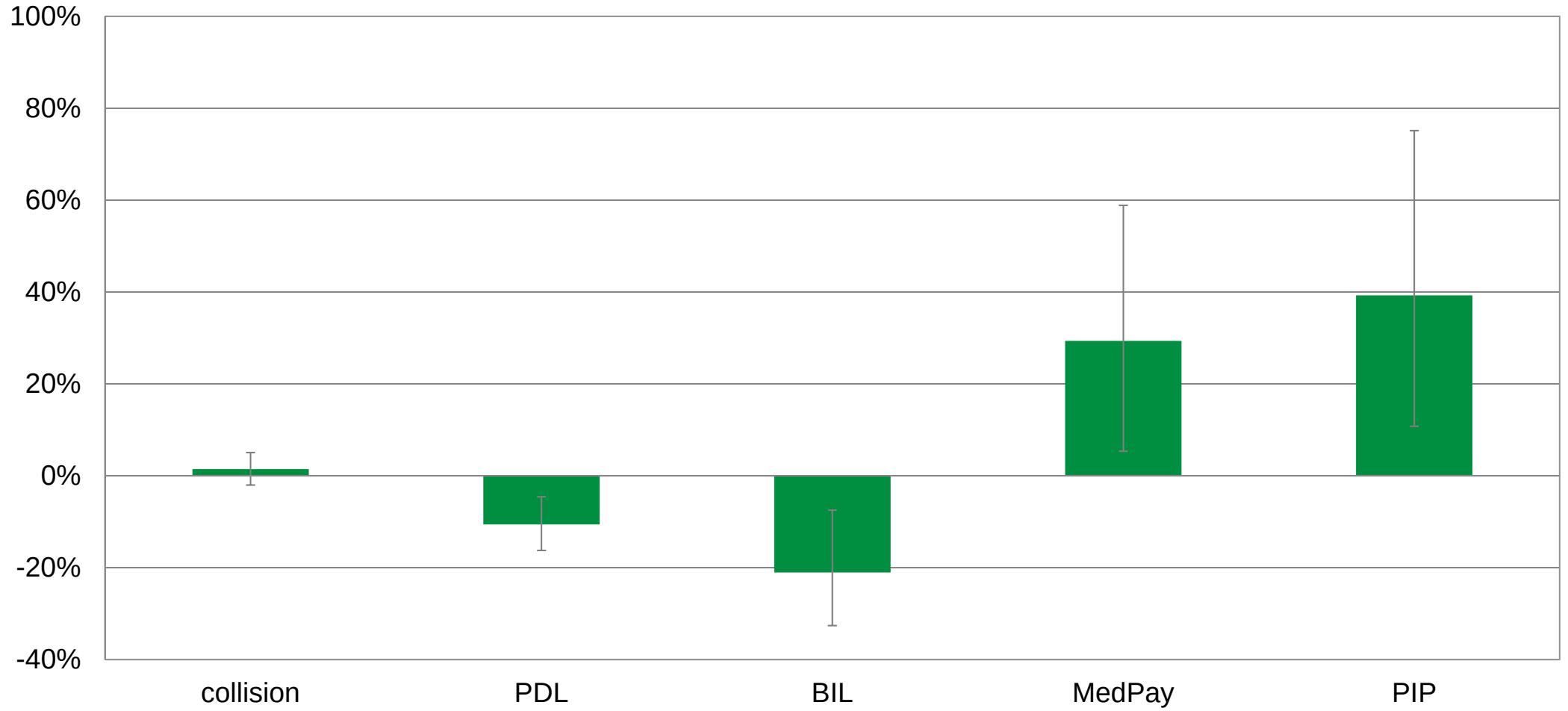


Tesla Model S ADAS timeline



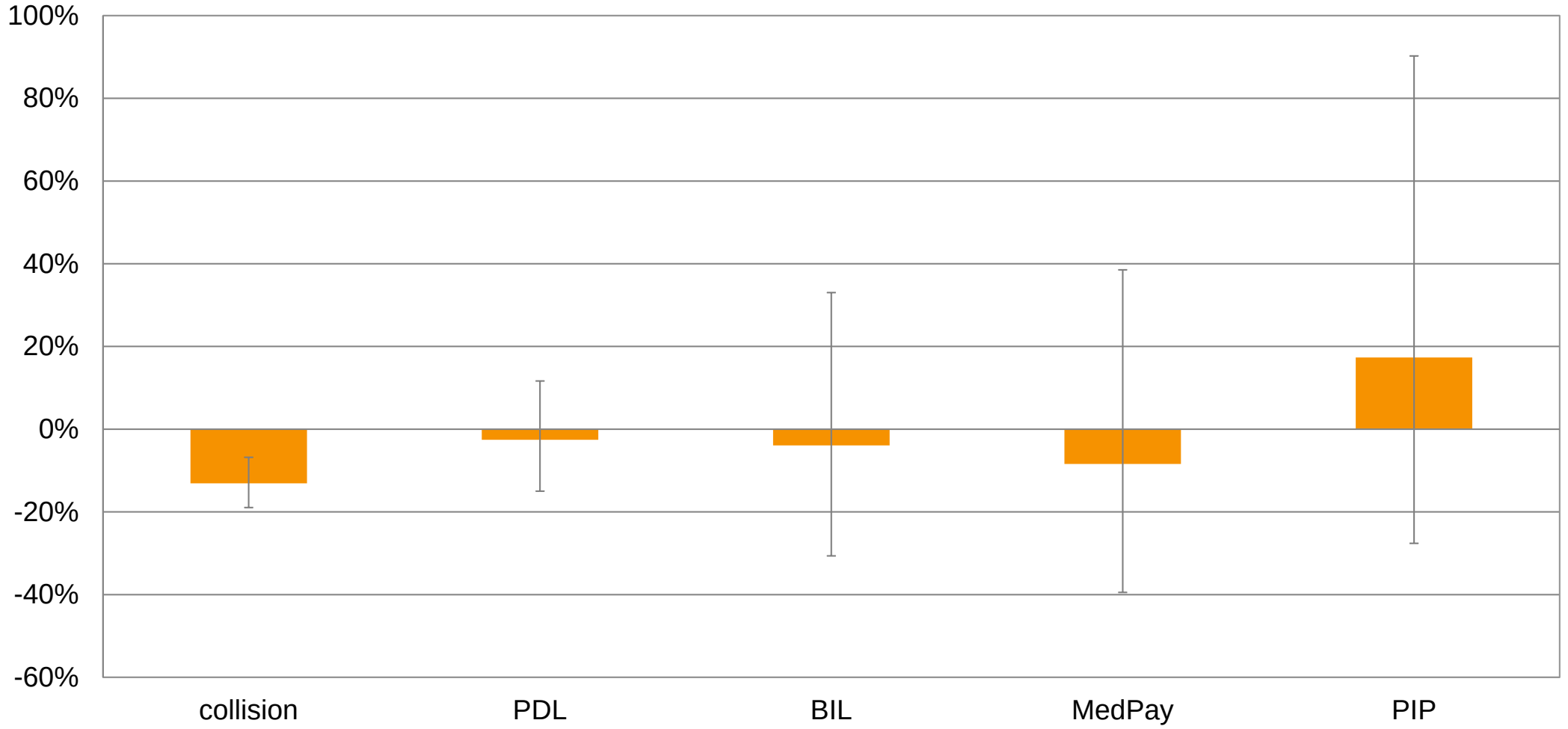
Estimated effect of Tesla Model S ADAS availability enabled by Hardware Version 1 on claim frequency

Driver assistance technology includes Autopilot, not a pure effect of Autopilot



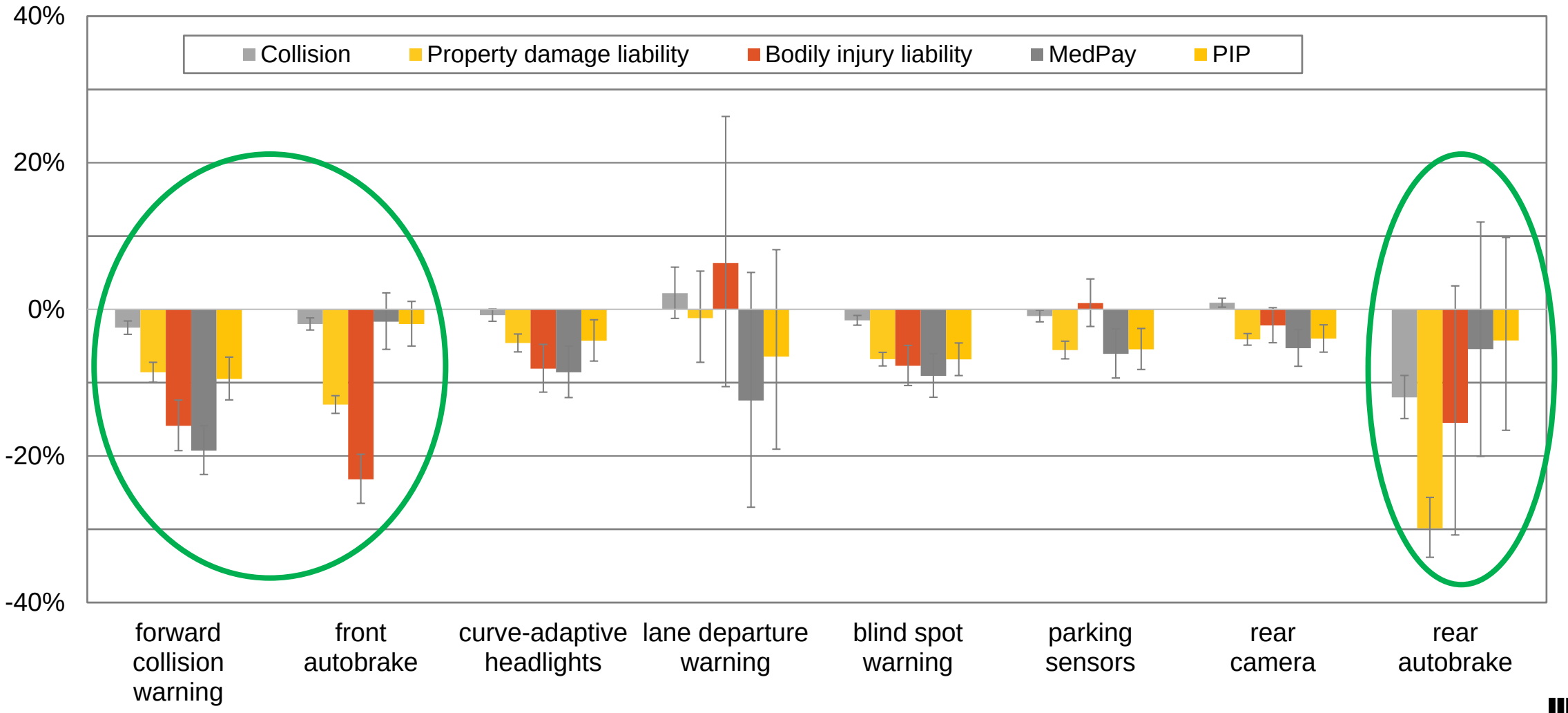
Estimated effect of Tesla Model S Autopilot availability on claim frequency, beyond earlier ADAS availability

Autopilot made available at the same time as other features, not a pure effect of Autopilot

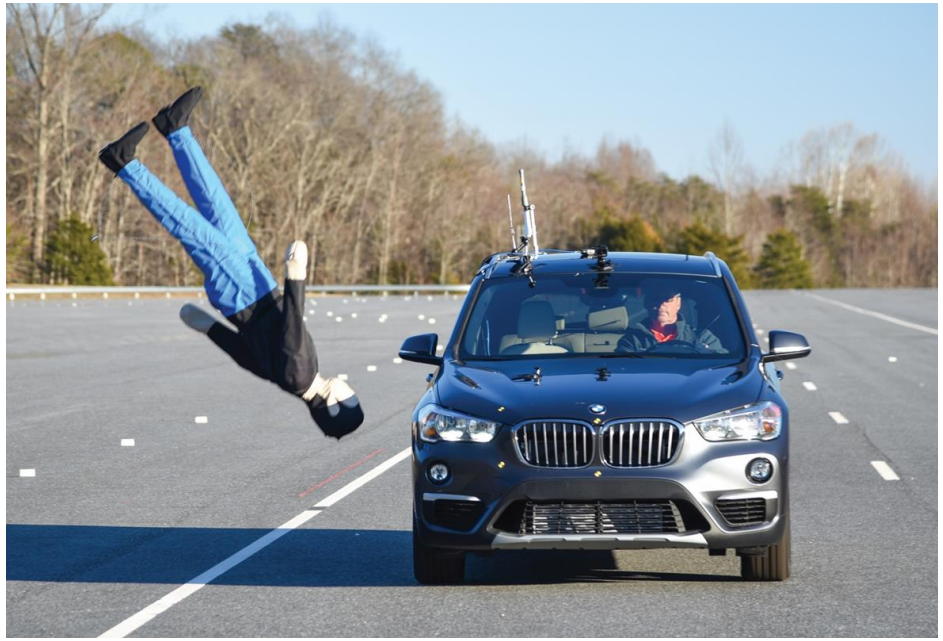


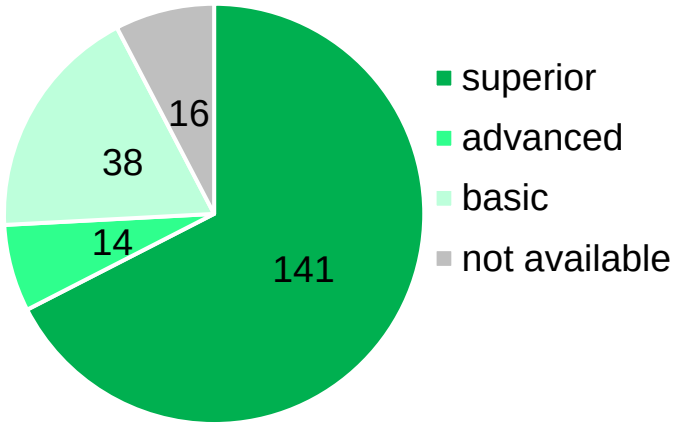
ADAS effects on claim frequency

Results pooled across automakers

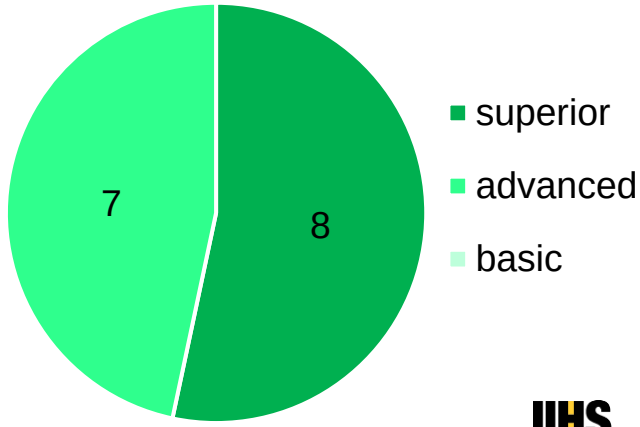


Ratings to promote ADAS that's proven to work





SUPERIOR	2018-19 Honda CR-V
	2019 Subaru Forester
	2019 Toyota RAV4
	2019 Volvo XC40
ADVANCED	2019 Chevrolet Equinox
	2018-19 Hyundai Kona
	2019 Kia Sportage
	2018-19 Mazda CX-5
	2019 Nissan Rogue
BASIC	2019 Mitsubishi Outlander
NO CREDIT	2018-19 BMW X1



Summary

IIHS/HLDI research program on driving automation

- Higher levels of automation
  - Won’t eliminate majority of crashes for a long time
  - Need for national reporting requirements for crashes and exposure in on-road testing
- SAE Level 2, Level 1
  - Drivers need clear and accurate communication from and about systems
  - Functional performance of systems must continue to improve and focus on safety
  - Evaluating relationship with claim/crash rates are still early and will improve over time
  - Ability to identify which vehicles have L2, and when they’re activated, is a challenge
  - Still much to learn about what’s good, bad, and to be expected, and how to measure

Insurance Institute for Highway Safety
Highway Loss Data Institute

More information at iihs.org and on our social channels:

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IIHS

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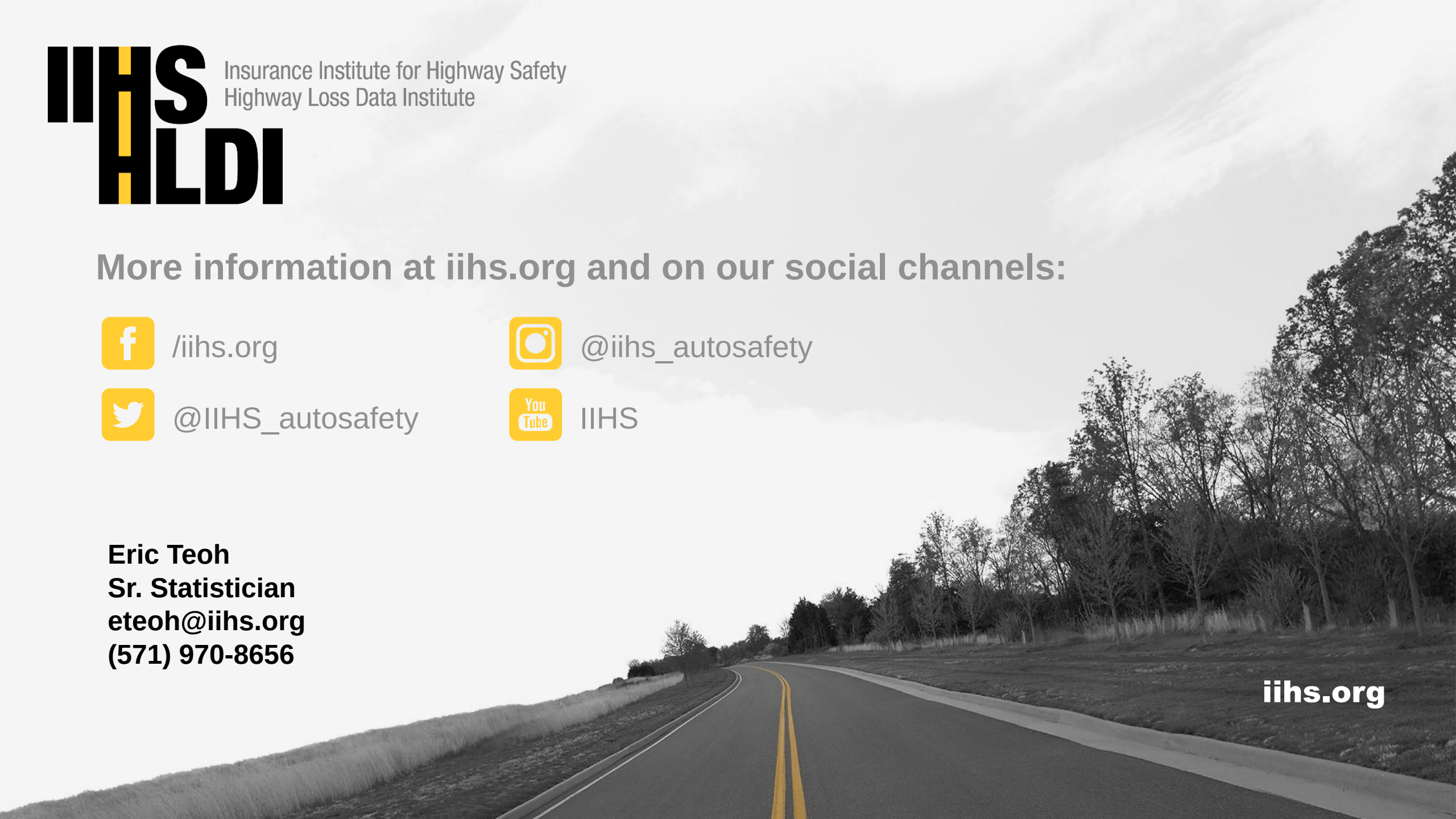

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