Autonomous Vehicles

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Technology Overview

What is an Autonomous Vehicle?

- Automated vehicles "detect, recognize, anticipate, and respond to the movements" of transportation system users
- Autonomous vehicles (AV) achieve these objectives without direct input from a human driver

USDOT, "Automated Vehicles 3.0"

Futurism

- **Reduced fuel usage**
- **Increased green space, reduced concrete coverage**
  - Driveways, parking lots, garages may not be necessary
- **Optimization of roadways and infrastructure**
- **Optimization of consumer goods deliveries**
- **Increased safety**
- **No vehicle “ownership”**
- **Repurposing of vehicles for work, resting, or entertainment**
- **No private vehicle insurance**
- **Obsolescence of drivers licenses**
- **Fewer limits on vehicle operation**

SAE Automation Levels

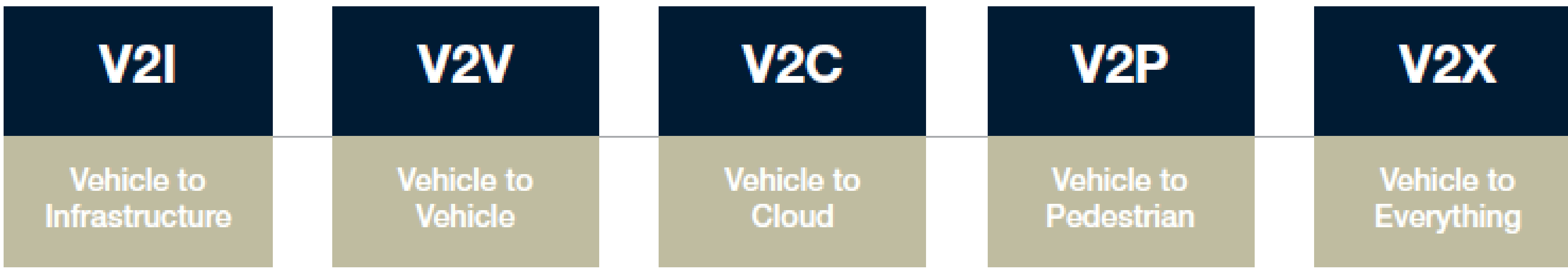
SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) AUTOMATION LEVELS

Full Automation

0	1	2	3	4	5
No Automation	**Driver Assistance**	**Partial Automation**	**Conditional Automation**	**High Automation**	**Full Automation**
Zero autonomy; the driver performs all driving tasks.	Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.	Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times.	Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.	The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.	The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.

https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety

Connected Cars



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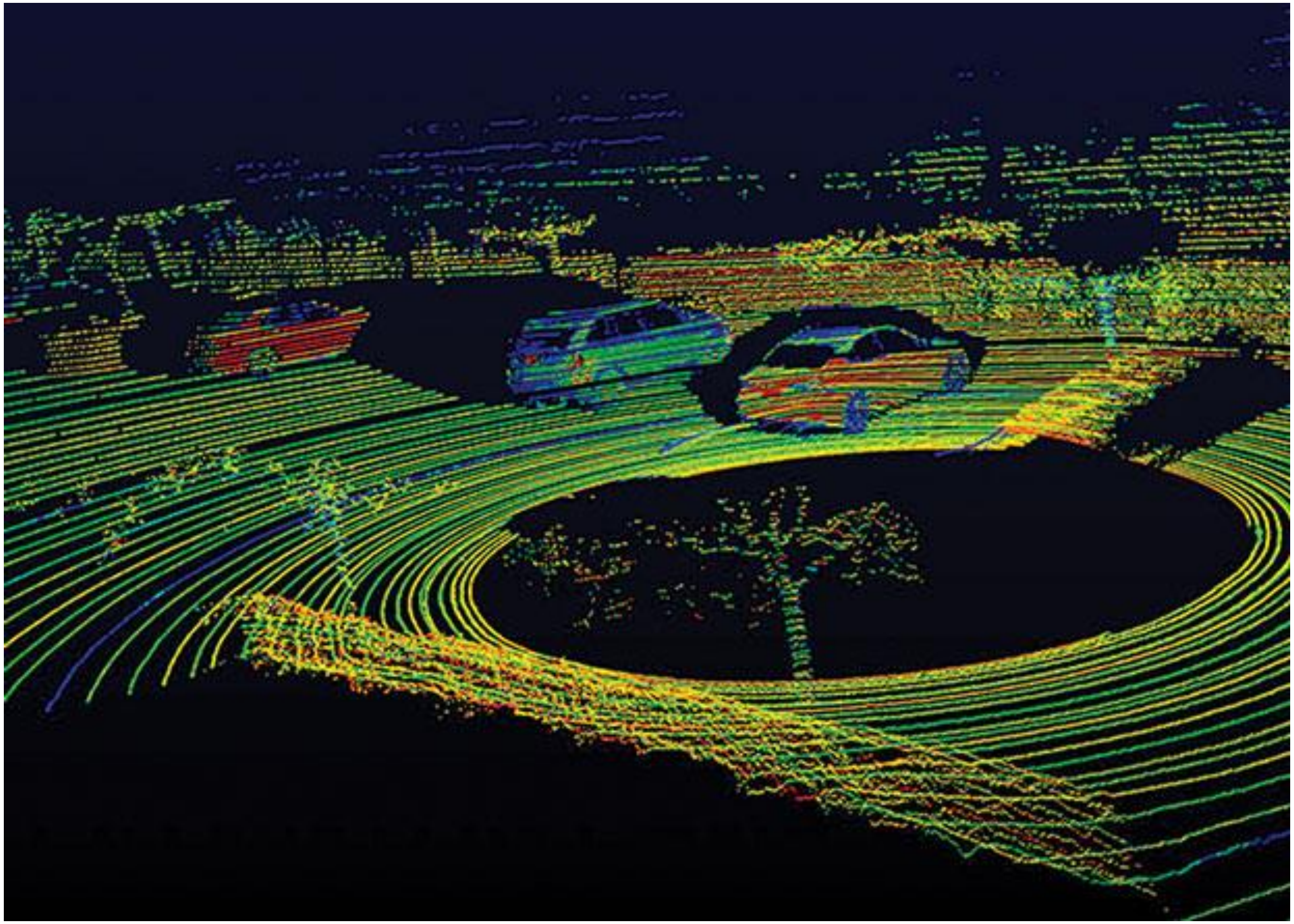
AV Market

- Expected to grow from $54 billion in 2019 to $557 billion in 2026
- Companies testing AVs, but all require back up drivers
- AVs with some self-driving capability expected in early 2020s
- Fully autonomous vehicles will not be available until late 2020s
- Opportunity areas:
  - Sensors
  - Cameras
  - Image processing
  - Radar
  - LiDAR
  - Data processing
  - Communication technologies
  - Artificial Intelligence
  - Security

LiDAR



Artificial Intelligence

– Three critical AI capabilities for full autonomy:

- **Object recognition and tracking:** identify and track objects on the road — be they pedestrians, signs, buildings or traffic lights — like humans do through their own perception

- **A motion predictor:** artificial intelligence to handle critical situations that come up while driving, for example a pedestrian running across the street, a car being sideswiped or hazardous weather conditions

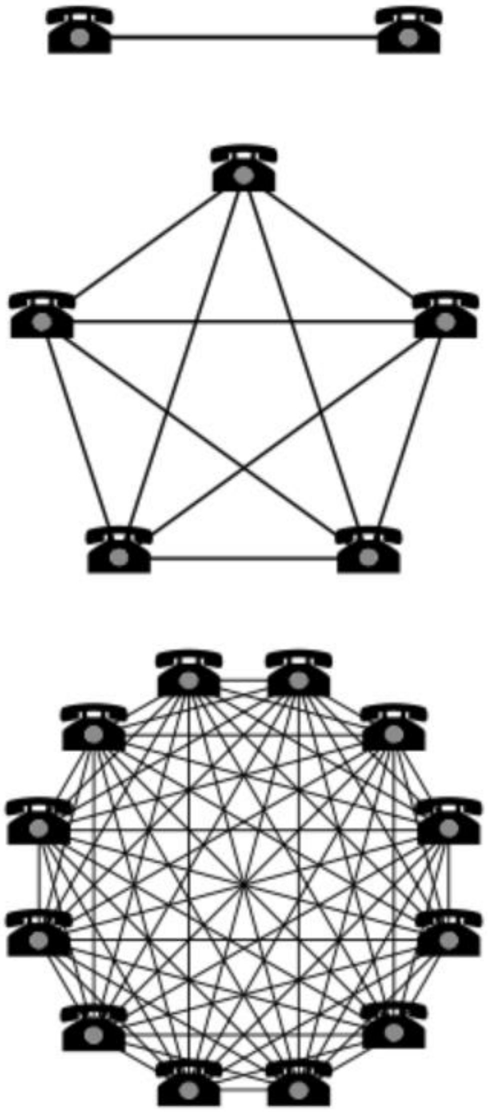
- **A situation analyzer:** compute and analyze gigabytes of data per second in real time to deliver data features that enable the motion predictor system to make intelligent decisions on the road

Big Data Feeds “AI” Systems

- **23 to 25 million kilometers of driving to collect data and train the <u>neural networks</u> that will make autonomous cars feasible**
  - 1 million person years per simple capability to label the data

- **Evolving autonomous driving could generate in excess of 100 exabytes of data**
  - 100 x 10^{18} (or **100 million** terabyte drives)
  - Data storage
  - Data communication (**5G**)
  - Data privacy
  - Data and communication security

Network Effects



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Technology Challenges

Infrastructure Challenges

- Pavement markings
- Signing
- Traffic signals
- Maintenance
- Consistency and standardization
- Data capture and information sharing and inventory
- Communication infrastructure
- High-resolution mapping

Preparing Local Agencies for the Future of Connected and Autonomous Vehicles, http://www.dot.state.mn.us/research/reports/2019/201918.pdf

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AV Technology Development

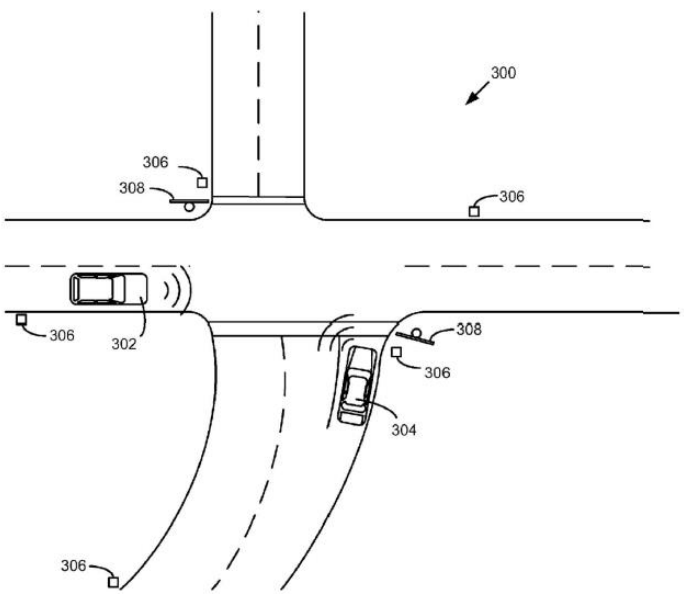
(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2017/0131719 A1**

Micks et al. (43) **Pub. Date: May 11, 2017**

(54) **AUTONOMOUS DRIVING AT INTERSECTIONS BASED ON PERCEPTION DATA**

(71) Applicant: **Ford Global Technologies, LLC**, Dearborn, MI (US)



(52) **U.S. Cl.**
CPC ***G05D 1/0246*** (2013.01); ***G08G 1/161*** (2013.01); ***B60W 40/08*** (2013.01)

(57) **ABSTRACT**

Systems, methods, and devices for predicting a driver's intention and future movements of a proximal vehicle, whether an automated vehicle or a human driven vehicle, are disclosed herein. A system for predicting future movements of a vehicle includes an intersection component, a camera system, a boundary component, and a prediction component. The intersection component is configured to determine that a parent vehicle is near an intersection. The camera system is configured to capture an image of the proximal vehicle. The boundary component is configured to identify a sub-portion of the image containing a turn signal indicator on the proximal vehicle. The prediction component is configured to predict future movement of the proximal vehicle through the intersection based on a state of the turn signal indicator.

AV Technology Development

(12) **United States Patent**
Baalke et al.

(10) **Patent No.: US 10,338,591 B2**
(45) **Date of Patent: Jul. 2, 2019**

(54) **METHODS FOR AUTONOMOUSLY NAVIGATING ACROSS UNCONTROLLED AND CONTROLLED INTERSECTIONS**

(71) Applicant: **Amazon Technologies, Inc.**, Seattle, WA (US)

(72) Inventors: **Uriah Baalke**, San Francisco, CA (US); **Stav Braun**, San Francisco, CA (US); **Sonia Jin**, San Francisco, CA (US)

(73) Assignee: **Amazon Technologies, Inc.**, Seattle, WA (US)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,504,530	B1	1/2003	Wilson et al.
7,339,993	B1	3/2008	Brooks et al.

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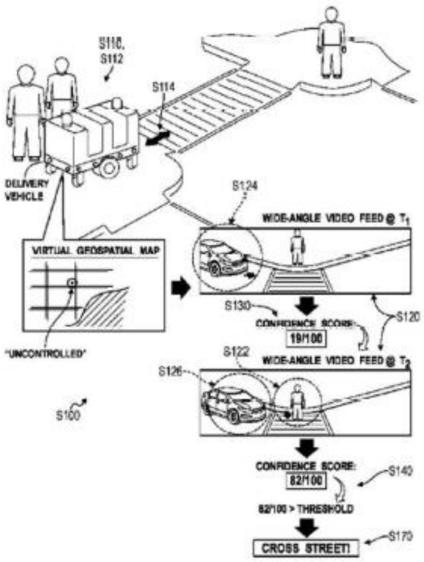
WO	2015134376	A1	9/2015

(57) **ABSTRACT**

One variation of a method for autonomously navigating along a crosswalk includes: at a first time, navigating autonomously along a sidewalk toward a crosswalk coinciding with a navigation route assigned to the autonomous vehicle; recording optical data of a scene proximal the autonomous vehicle via an optical sensor integrated into the autonomous vehicle; aligning an anteroposterior axis of the autonomous vehicle to the crosswalk detected in the optical data; identifying a pedestrian proximal the crosswalk in the optical data; in response to the pedestrian entering the crosswalk at a second time succeeding the first time, predicting right of way of the autonomous vehicle to enter the crosswalk; and, in response to predicting right of the autonomous vehicle to enter the crosswalk, autonomously navigating from the sidewalk into the crosswalk and autonomously navigating along the crosswalk to an opposing sidewalk according to the navigation route.



AV Technology Development

(12) **United States Patent**
Agnew et al.

(10) **Patent No.: US 9,809,219 B2**
(45) **Date of Patent: Nov. 7, 2017**

(54) **SYSTEM FOR ACCOMMODATING A PEDESTRIAN DURING AUTONOMOUS VEHICLE OPERATION**

(71) Applicant: **Continental Automotive Systems, Inc.**, Auburn Hills, MI (US)

(72) Inventors: **David Leslie Agnew**, Clarkston, MI (US); **Graham Lanier Fletcher**, North Augusta, SC (US)

(2013.01); *B60W 2710/18* (2013.01); *B60W 2710/20* (2013.01); *B60W 2720/10* (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

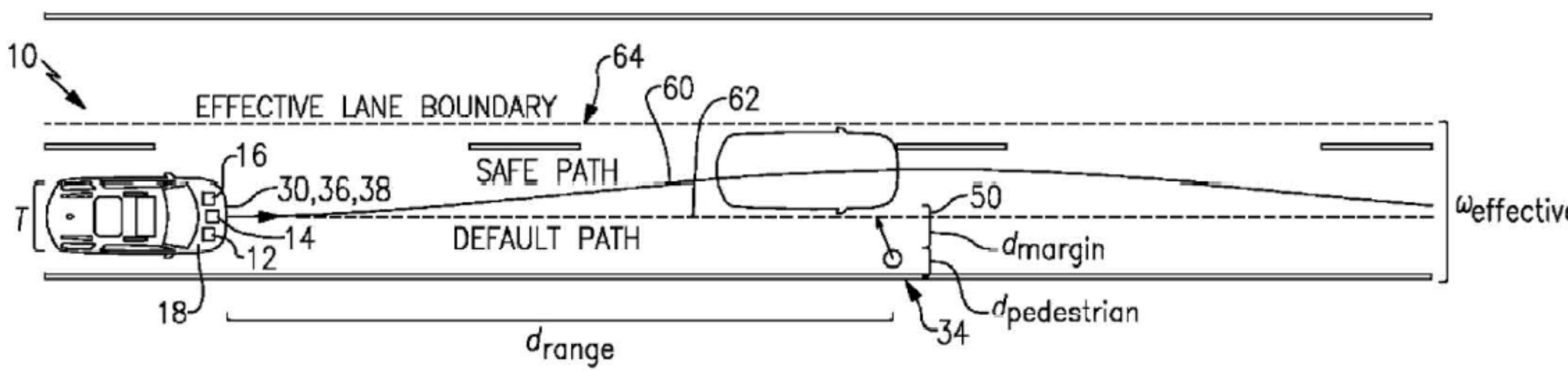
(56) **References Cited**

U.S. PATENT DOCUMENTS

8,489,281 B2 * 7/2013 Reichel B62D 15/0265

(57) **ABSTRACT**

A collision avoidance system for a vehicle includes an electronic brake system capable of applying wheel brakes to decelerate the vehicle, a steering system capable of changing a steering angle for the vehicle, and a controller. The controller instructions for performing a pedestrian avoidance maneuver including at least one of steering the vehicle to the maximum available separation distance and braking the vehicle to the maximum safe speed while the vehicle is passing the pedestrian.



AV Technology Development

(12) **United States Patent**
Slusar

(10) **Patent No.:** **US 9,355,423 B1**
(45) **Date of Patent:** **May 31, 2016**

(54) **REWARD SYSTEM RELATED TO A VEHICLE-TO-VEHICLE COMMUNICATION SYSTEM**

(71) Applicant: **Allstate Insurance Company**, Northbrook, IL (US)

(72) Inventor: **Mark V. Slusar**, Chicago, IL (US)

(73) Assignee: **Allstate Insurance Company**, Northbrook, IL (US)

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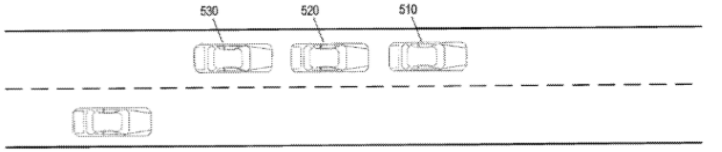


FIG. 6A

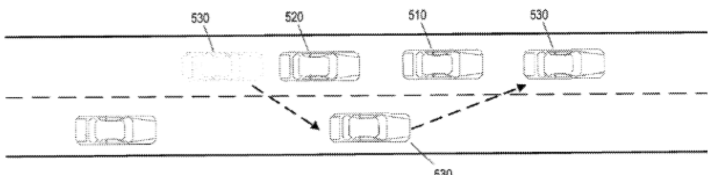
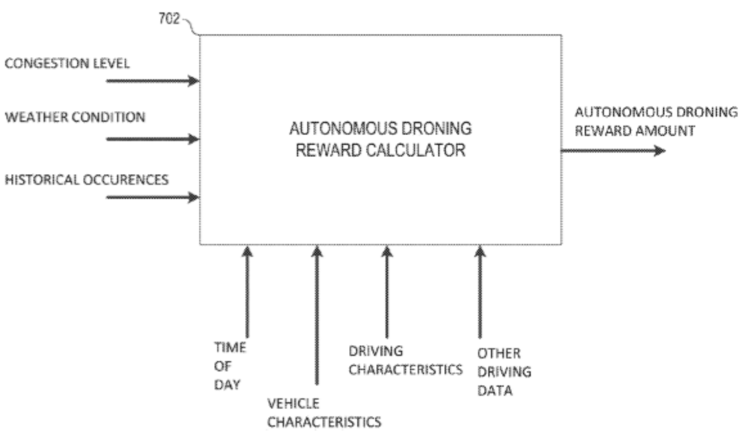


FIG. 6B



(57) **ABSTRACT**

System and methods are disclosed for determining, through vehicle-to-vehicle communication, whether vehicles are involved in autonomous droning. Vehicle driving data and other information may be used to calculate a autonomous droning reward amount. In addition, vehicle involved in a drafting relationship in addition to, or apart from, an autonomous droning relationship may be financially rewarded. Moreover, aspects of the disclosure related to determining ruminative rewards and/or aspects of vehicle insurance procurement/underwriting.

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Legal Considerations

Patents—The Numbers

- Patent applications related to AV technologies have grown 20-30% since 2016
- United States accounts for 75% of new patent filings for AV technologies
- Broad range of applicants

Patent Protection—The Issues

- **Section 101 Issues**
  - *Mayo Collaborative Services v. Prometheus Labs., Inc*., 132 S. Ct. 1289 (2012), the Supreme Court articulated a two-part analytical framework for determining whether a claim is patent-eligible under 35 U.S.C. § 101
  - *Alice Corp. Pty. Ltd. v. CLS Bank Int'l*, 134 S. Ct. 2347 (2014), the Supreme Court applied the Mayo-test to abstract ideas.
- **Inventions created by AI**
  - United States Constitution grants Congress the power "[t]o promote the progress of science and useful arts, by securing for limited times to *authors and inventors* the exclusive right to their respective writings and discoveries." U.S. Const. art. I, § 8, cl. 8 (emphasis added)
  - The PTO is considering, and seeking public input on, its approach to AI.
- **Patents infringed by AI**
  - Who is the infringer?
  - Venue and pleading issues

Trade Secrets

- A trade secret plaintiff has the burden of establishing the existence of a trade secret, which requires showing that it
  - is valuable
  - is not known to others who might profit by its use, and
  - has been handled by means reasonably designed to maintain secrecy. *Kuryakyn Holdings, LLC v. Ciro, LLC*, 242 F. Supp. 3d 789, 798 (W.D. Wis. 2017).
- May solve some problems with patent challenges
- Protection of "negative know-how"
- Secrecy vs. susceptibility to reverse engineering
- Impact of high mobility
  - Detroit vs. Silicon Valley

Trade Secrets in the AV Space

- **Value of trade secrets vs. patents**
  - Avoiding potential patent challenges
  - Protection of negative know-how

- **But….**
  - Ease of data transfer
  - Maintaining robust upfront policies for new employees and departing employees
  - Need to identify specific trade secrets-no moving targets
  - Demonstrating misappropriation and use

Data Privacy and Security

Data Privacy and Security

- AV data includes location, speed, daily routes, and more
- Who owns the data?
- How is the data protected?
- National Highway Traffic Safety Administration (NHTSA) provides voluntary guidelines for AV regulation, including guidelines on cybersecurity

Product Liability

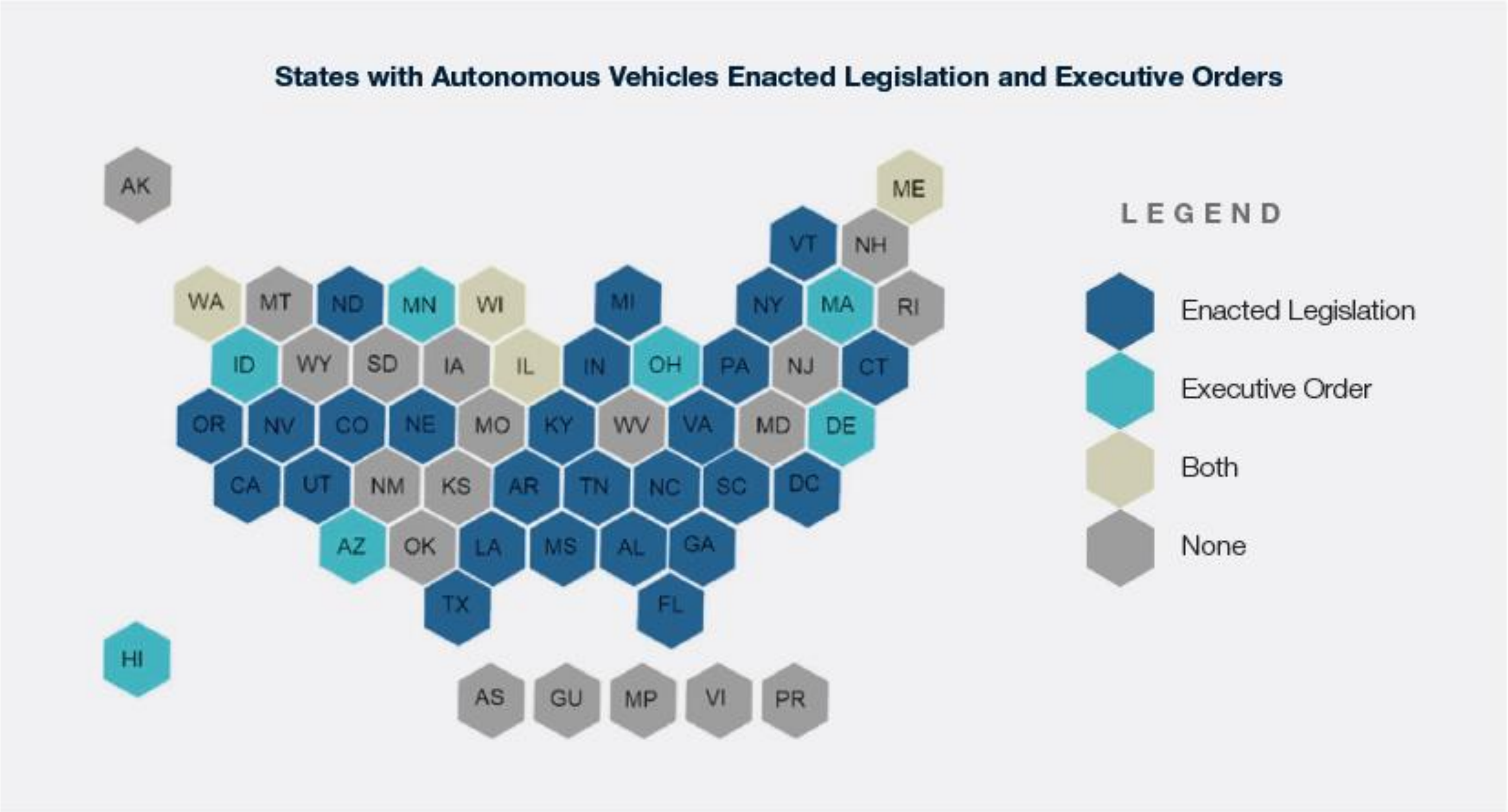
- **Types of vehicles involved in the collision:**
  - Non-AV accidents - tort law (negligence)
  - AV/AV accidents - may be product liability law (i.e., questions around defective designs)
  - AV/non-AV accidents - ?
- **Causation:**
  - Different types of causation in accidents involving AVs may result in differing liabilities
  - Complex forensic and technical investigation may be needed to determine the cause of the accident
  - Whether the accident was caused by human error or defect of the AV
- **Fault allocation:**
  - May depend on who or what had control over the condition causing the accident
  - Presumptions for AV levels?

Case Examples Involving AV Accidents

- ***Wood v. Arizona*, CV 2019-090948 (Superior Court of the State of Arizona, Maricopa County)**
  - Elaine Herzberg - first person to die in an AV accident, after being hit by a Volvo XC90 in autonomous mode
  - Family sued the State of Arizona and City of Tempe for $10 million based on the physical conditions of the road as well as Arizona's policy of allowing AV testing
  - At the time of the accident, the AV driver was watching a video on her phone
  - Case pending as of Summer 2019
- ***Sz Hua Huang et al v. Tesla Inc*., 19-CV-346663 (California Superior Court, County of Santa Clara)**
  - California state court action alleging product liability, defective product design, failure to warn, intentional and negligent misrepresentation, and false advertising
  - Tesla owner died after the vehicle collided with the concrete median that the vehicle did not detect

Regulations

No specific federal regulations yet, but 37 states have enacted AV regulations



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Questions?

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