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INTRODUCTION

Just as "lions and tigers and bears" seemed foreboding in Oz,[1] vehicle technologies that enable cars to operate themselves may seem disquieting. The legal ecosystem that awaits the first generation of fully autonomous passenger cars can appear equally ominous. In fact, the legal system may not be nearly as hostile to autonomous cars as some may fear; and the first generation of autonomous cars will not be scary at all when they begin to share the roadways with conventional vehicles operated in whole or in part by human drivers. Partly automated and semi-autonomous vehicles will have been on the

1. In the 1939 MGM musical version of *The Wizard of Oz*, Dorothy famously exclaims, "Lions and tigers and bears! Oh my!" about a frightening, further phase of her adventures. *See* L. FRANK BAUM, THE ANNOTATED WIZARD OF OZ: CENTENNIAL EDITION 125 (Michael Patrick Hearn ed., 2000).

road for some time when these first generation autonomous cars become available on the consumer market in the early 2020s. From the outside, these first autonomous cars will probably appear very similar to conventional vehicles on the road. Inside will of course be very different as computerized systems, instead of human drivers, operate these cars. Indeed, there may be no humans at all in some first generation autonomous cars.

This Article considers the legal system that awaits the first fully autonomous passenger vehicles to reach consumer markets. These first generation autonomous cars will be an initial step beyond conventional, human-directed automobiles into a future in which ever more advanced vehicles, which do not need humans as drivers, will predominate. In a sense, the first generation of autonomous cars will play a transitional role, linking familiar, human-driven cars with advanced autonomous vehicles that may be configured very differently from the cars we know today.

Experimental versions of fully autonomous vehicles exist now.[2] They include heavy trucks and other commercial vehicles, as well as passenger cars.[3] However, the focus here is on the first generation of autonomous passenger cars to reach consumers. Experimental models are prominently featured at auto and electronics shows. This Article sketches a vision of these first commercially available driverless passenger cars, the ways in which these autonomous vehicles may be used, and how the legal system, which now pervasively assumes the presence of a human driver in control of every car, is likely to embrace these first autonomous passenger cars. The discussion begins with considering how the consumer market is likely to want to use autonomous cars. Next, this Article addresses some of the problematic terminology, such as "connected vehicles," that confuses policy decisions about autonomous cars, followed

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2. *See, e.g.*, *Just Press Go: Designing a Self Driving Vehicle*, GOOGLE (May 27 2014), http://googleblog.blogspot.com/2014/05/just-press-go-designing-self-driving.html.

3. *See, e.g.*, Doug Newcomb, *Daimler Autonomous Truck Has Huge Commercial Implications*, FORBES (May 8, 2015, 1:30 PM), http://www.forbes.com/sites/dougnewcomb/2015/05/08/daimler-autonomous-truck-has-huge-commercial-implications/; Viknesh Vijayenthiran, *Meet Mercedes-Benz's Futuristic Autonomous Truck Concept: Video,* MOTOR AUTHORITY (Sept. 23, 2014), http://www.motorauthority.com/news/1094568_meet-mercedes-benzs-futuristic-autonomous-truck-concept-video.

by an explanation of the nature of autonomous vehicle technologies. The Article then discusses some of the ways in which the legal system may facilitate or frustrate commercial availability of autonomous passenger cars, including the potential for a hypothetical National Autonomous Vehicle Act. Finally, the Article concludes by considering whether the first generation of autonomous cars is likely to deliver the promised safer, more efficient, and environmentally friendly personal mobility.

I. FIRST GENERATION AUTONOMOUS CARS

The size and shape of the potential consumer market for the first generation of autonomous vehicles is a matter of extensive debate.[4] Some predict that only wealthy early-adopters will choose autonomous cars, which initially are likely to be expensive and few in number.[5] Others predict near-term widespread use of driverless cars.[6] Most of these predictions are simply guesses—some more informed than others.[7]

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4. *See* ERNST & YOUNG, DEPLOYING AUTONOMOUS VEHICLES: COMMERCIAL CONSIDERATIONS AND URBAN MOBILITY SCENARIOS (2014), *available at* http://www.ey.com/Publication/vwLUAssets/EY-Deploying-autonomous-vehicles-30May14/$FILE/EY-Deploying-autonomous-vehicles-30May14.pdf; *Back to the Future: The Road to Autonomous Driving*, BOS. CONSULTING GROUP (Jan. 8, 2015), http://www.slideshare.net/TheBostonConsultingGroup/the-road-to-autonomous-driving.

5. *E.g.*, Todd Litman, *Ready or Waiting?*, TRAFFIC TECH. INT'L, Jan. 2014, at 36, 42, *available at* http://viewer.zmags.com/publication/38bd52e3#/38bd52e3/38 (noting that the cost of making autonomous vehicles is uncertain, but the sensors, computers, and controls currently cost tens of thousands of dollars). Both the Ernst & Young and Boston Consulting Group reports estimate the additional cost at around $10,000 per autonomous car. *See* sources cited *supra* note 4.

6. *E.g.*, *Autonomous Cars: The Future Is Now*, MORGAN STANLEY (Jan. 23, 2015), http://www.morganstanley.com/articles/autonomous-cars-the-future-is-now/.

7. The following table illustrates one of the more conservative predictions of market penetration of autonomous cars.

Stage	**Decade**	**Vehicle Sales**	**Vehicle Fleet**	**Vehicle Travel**
Available with large price premium	2020s	2%–5%	1%–2%	1%–4%
Available with moderate price premium	2030s	20%–40%	10%–20%	10%–30%
Available with minimal price premium	2040s	40%–60%	20%–40%	30%–50%

A. USES FOR AUTONOMOUS CARS

There will be a wide range of potential uses for first generation autonomous cars, including individually-owned personal or family cars, online ride-service cars, rental cars for short-term mobility and transport needs, small-scale local commercial delivery services, paratransit offering mobility services for elderly and disabled persons, and fleets owned by corporations or other entities for their own use.

Sorting out what is to encourage or discourage consumer interest in purchasing and using autonomous cars is guesswork. Nevertheless, it is fair to project that some of the factors likely to encourage consumer interest in autonomous cars will include repeated journeys along the same routes, availability of real-time data, including maps of road and traffic conditions, slow-moving traffic, frequent congestion caused by car crashes, safety, time-savings, and other efficiencies. Among the factors that seem likely to discourage consumer interest in the first generation autonomous cars are cost, uncertainties about risks of vehicle malfunction, roadway risks involving both the infrastructure and non-vehicle road users (pedestrians, bicycles, etc.), roadway risks from human-driven vehicles, and preference for control by human drivers.

Urban settings are likely to be more favorable environments for autonomous cars than rural and remote areas, where accurate and timely roadway mapping and other infrastructure may be unavailable or uneconomic. It is unclear whether autonomous cars will be preferred for long or short journeys. However, to the extent that autonomous cars are confined (by technological factors such as mapping, communications, or infrastructure) to prescribed local areas, as opposed to a wider regional and national range of operation, such a restricted geographical scope would tend to discourage general consumer use.

Standard feature included on most new vehicles	2050s	80%–100%	40%–60%	50%–80%
Saturation (everybody who wants it has it)	2060s	?	?	?
Required for all new and operating vehicles	?	100%	100%	100%

TODD LITMAN, VICTORIA TRANSP. POL'Y INST., AUTONOMOUS VEHICLE IMPLEMENTATION PREDICTIONS: IMPLICATIONS FOR TRANSPORT PLANNING 11 (2015), *available at* http://www.vtpi.org/avip.pdf.

B. AUTONOMOUS CARS IN CONTROLLED ENVIRONMENTS

The earliest first generation autonomous cars may well be initially deployed in controlled environments to minimize legal risks from personal injuries, property damage, and other adverse interactions involving unpredictable events such as unexpected pedestrians, road closures, unanticipated road construction, or repairs.[8] For example, Google's announced development of two-person, low-speed autonomous cars appears to be among the earliest of these applications.[9] Google has indicated that it is in the process of building a fleet of vehicles of this type that the company intends to license in California, once the California Department of Motor Vehicles adopts operational regulations.[10] Google managers have stated that the corporation does not plan to go into the autonomous car business.[11] Rather, at least initially, the corporation plans to keep its autonomous cars for use primarily by Google employees on and around the corporation's campus.[12] The cars will be classified as low-speed vehicles limited to twenty-five miles per hour.[13] This low-speed classification limits roadway accident risks and allows for a smaller, lighter car body under the National Highway Traffic Safety Administration's (NHTSA) special regulatory category for low speed vehicles.[14]

Whether such an application characterized by limited, protected, and well-mapped routes is likely to be extrapolated

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8. *Id.* at 9, 16.

9. Matt O'Brien, *Google's 'Goofy' Car a Sign of Things to Come*, SAN JOSE MERCURY NEWS (Dec. 22, 2014, 04:42 PM), http://www.mercurynews.com/business/ci_27190285/googles-goofy-new-self-driving-car-sign-things; *What We're Driving At*, GOOGLE (Oct. 9, 2010), http://googleblog.blogspot.com/2010/10/what-were-driving-at.html.

10. Liz Gannes, *Google's New Self-Driving Car Ditches the Steering Wheel*, Re/code (May 27, 2014, 6:59 PM), http://recode.net/2014/05/27/googles-new-self-driving-car-ditches-the-steering-wheel/; O'Brien, *supra* note 9 (describing how the Google car still requires government approval).

11. Joseph B. White & Rolfe Winkler, *Google Seeks Partners for Self-Driving Car*, WALL ST. J. (Dec. 19, 2014, 5:06 PM), http://www.wsj.com/articles/google-seeks-partners-for-self-driving-car-1419026779.

12. O'Brien, *supra* note 9.

13. *See* Low Speed Vehicles, 49 C.F.R. § 571.500 (2011); NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP'T OF TRANSP., REQUIREMENTS FOR MANUFACTURERS OF LOW SPEED VEHICLES PRODUCED FOR DISTRIBUTION WITHIN THE U.S. MARKET 3 (2008), *available at* http://www.nhtsa.gov/cars/rules/maininfo/lowspeedvehicle.pdf.

14. *See* NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP'T OF TRANSP., *supra* note 13.

to broader uses by consumers remains to be seen. If consumer models of autonomous cars are limited to the small, low-speed vehicle regulatory category, the potential consumer market may be limited to retirement and other planned communities that emphasize alternatives to conventional automobiles.[15] On the other hand, in some large cities, such as New York, the maximum speed limit is already twenty-five miles per hour.[16] In such congested areas, low-speed, few-passenger autonomous cars of the type Google is developing could be useful for local trips. On the other hand, such densely populated, congested urban areas are also subject to enhanced risks from unexpected human behavior and problems that can pop up unexpectedly on urban roadways. Once autonomous cars are licensed for use on local roadways, legal rules and liabilities may change to adapt to autonomous cars in highly populated areas, just as legal rules and liabilities have adjusted to low-speed vehicles.[17]

C. RIDE SERVICES

When consumers are asked about the application of autonomous cars most people want to be available first, consumers often choose on-demand personal mobility services, similar to online ride services, known as Transportation Network Companies.[18] These services would provide

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15. *See* WILLIAM L. GARRISON & DAVID M. LEVINSON, THE TRANSPORTATION EXPERIENCE: POLICY, PLANNING, AND DEPLOYMENT 418 (2014) (describing examples including the Del Web Sun City retirement communities and Celebration in Florida); DANIEL SPERLING & DEBORAH GORDON, TWO BILLION CARS: DRIVING TOWARD SUSTAINABILITY 41 (2009).

16. Bill de Blasio, Mayor of N.Y.C., Mayor de Blasio Signs New Law Lowering New York City's Default Speed Limit to 25 MPH (Oct. 27, 2014), *available at* http://www1.nyc.gov/office-of-the-mayor/news/494-14/transcript-mayor-de-blasio-signs-new-law-lowering-new-york-city-s-default-speed-limit-25-mph (stating that since November 7, 2014, the speed limit on all streets in New York City has been twenty-five miles per hour unless otherwise posted); Jim Gorzelany, *The World's Most Traffic-Congested Cities*, FORBES (Apr. 25, 2013, 8:27 AM), http://www.forbes.com/sites/jimgorzelany/2013/04/25/the-worlds-most-traffic-congested-cities/ (noting that Manhattan's actual average road speed hovers around thirteen miles per hour).

17. Amanda Taylor Poncy et al., *Policy and Design Considerations for Accommodating Low-Speed Vehicles and Golf Carts in Community Transportation Networks*, 54 AARP PUB. POL'Y INST., INSIGHT ON ISSUES, Sept. 2011, at 1, 2, *available at* http://assets.aarp.org/rgcenter/ppi/liv-com/insight54.pdf.

18. *See, e.g.*, Antonio Loro, *Driverless Taxis: The Next Next Big Thing in Urban Transportation?*, PLANETIZEN (May 6, 2014, 6:00 AM),

convenience and privacy when a driverless car transports people to and from local destinations. Such a transportation-as-service approach is potentially transformative in changing expectations about personal mobility away from the purchase of a machine that one owns, maintains, and drives. First generation autonomous cars could well become the expected mode of on-demand personal transport that individuals can summon online when needed. Existing ride-service applications popularized by Uber, Lyft, Sidecar, and other similar ventures in urban areas are a frequently mentioned business model for using autonomous cars. Potential users view transportation by a vehicle without a driver as potentially more reliable and private with more personal space than current varieties of ride services that employ human drivers. Variations on using autonomous cars for ride services could include cooperatives that provide fleets of autonomous cars owned in common and available for use by members of the autonomous car cooperative.

D. AUTOMATED DRIVING SYSTEMS THAT ARE NOT QUITE AUTONOMOUS

Some observers believe that the first generation of autonomous cars will take the form of a cooperative car-train that emulates truck platoon systems such as that provided by Peloton Technology in the United States.[19] In Europe**,** the Safe Road Trains for the Environment Project **(**SARTRE Project) was established by the European Commission and successfully "develop[ed] strategies and technologies to allow vehicle platoons to operate on normal public highways with significant environmental, safety and comfort benefits."[20] Such a follow-

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http://www.planetizen.com/node/68657; *see also* Bora Alp Baydere et al., Car-Sharing Service Using Autonomous Automobiles 3 (Spring 2014) (unpublished manuscript), *available at* http://web.stanford.edu/class/me302/PreviousTerms/2014-06Car-SharingServiceUsingAutonomousAutomobiles%28paper%29.pdf.

19. PELOTON TECH., http://www.peloton-tech.com (last visited Feb. 23, 2015). Peloton is an automated vehicle technology company that utilizes vehicle-to-vehicle communications and radar-based active braking systems, combined with sophisticated vehicle control algorithms, to link pairs of heavy trucks. The safety systems are always active, and when the trucks are out on the open road, they can form close-formation platoons. *Id.*

20. SARTRE PROJECT, http://www.sartre-project.eu/en/Sidor/default.aspx (last visited Feb. 23, 2015); *see also* Ian Norwell, *Road Trains on Track?*,

the-lead-truck strategy does not involve vehicles that are, strictly speaking, driverless at all times. Interestingly, in some states there are legal impediments to lawful operation of truck platoons, including state laws that ban "truck convoys."[21] In addition, a number of state statutes require large intervals between vehicles under "following too close" prohibitions.[22] Nevertheless, extension of these platoon designs to "car-trains" or even car-truck mixed platoons would be feasible.[23] They would employ wireless communications linking one platooned vehicle to the next. However, cars using such trains would not be autonomous in the sense discussed here. They still need human drivers to hook up with, enter, and eventually leave the platoon, even though no active driver would be necessary during much of the journey. This example of partly autonomous technology is distinct from a fully autonomous car operating by itself at all times, which is the main focus of this Article.

Similarly, cars that are remotely controlled by external operators are not autonomous in the sense discussed here. Externally controlled cars would be in some sense driverless, but not exactly autonomous. Operational control by external managers simply moves the "driver" from inside the vehicle to a location outside the vehicle. Remote control cars are often remembered as familiar childhood toys. In the real world, they often take the form of large-scale trucks, digging equipment, and unmanned ground vehicles (UGVs) used in military and mining operations.[24] Similarly, remote control railroads have

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TRANSP. ENGINEER (Apr. 28, 2014), http://www.transportengineer.org.uk/transport-engineer-features/road-trains-on-track/60995.

21. *E.g.*, CAL. VEH. CODE § 21705 (West 2000) ("Motor vehicles being driven outside of a business or residence district in a caravan or motorcade, whether or not towing other vehicles, shall be so operated as to allow sufficient space and in no event less than 100 feet between each vehicle or combination of vehicles so as to enable any other vehicle to overtake or pass.").

22. *E.g.*, N.Y. VEH. & TRAF. LAW § 1129 (McKinney 2011) ("Following too closely. (c) Motor vehicles being driven upon any roadway outside of a business or residence district in a caravan or motorcade whether or not towing other vehicles shall be so operated as to allow sufficient space between each such vehicle or combination of vehicles so as to enable any other vehicle to enter and occupy such space without danger.").

23. *See* Sadayuki Tsugawa, Shin Kato & Keiji Aoki, *An Automated Truck Platoon for Energy Saving*, 1 IEEE INT'L CONF. ON INTELLIGENT ROBOTS & SYS. 4109, 4109–14 (2011).

24. *See, e.g.*, Mark L. Swinson, *Robotics, Military*, *in* 15 ENCYCLOPEDIA OF MICROCOMPUTERS 99, 105–07 (Allen Kent & James G. Williams eds., 1995); Horst Wagner, *Mining Technology for Surface and Underground Mining—*

been a feature of rail transport for a long time.[25] However, this Article is primarily concerned with the first autonomous cars to operate on public roads, where it is unlikely that remote control vehicles will play much of a role. Nevertheless, should passenger cars subject to remote control have commercial appeal, they would operate alongside the internally controlled autonomous cars that are the central focus of this Article.

Automated highway operation of passenger cars by internal systems—without the need for constant, active control by a driver—is already available. Such automated vehicle systems as adaptive cruise control with automatic lane keeping operate semi-autonomously in this way in particular driving environments. These and other forms of assisted human driving are generally lawful in most of the United States.[26] However, state laws still generally require that a licensed driver be in a position to take over otherwise-automated vehicle control at all times in the event of emergencies.[27] Currently available automated driver assistance systems are limited to particular driving operations (e.g., steering or braking) or specific environments (e.g., limited access highways or slow traffic). These assisted driving technologies also require a human driver to operate the vehicle in transitions between different types of roadway settings, from highway to arterial to residential roadways.

Autonomous cars are a technological step beyond automated technologies that assist drivers with warnings and automated controls. Before first generation autonomous cars take to the roads, they will need to perform internally, without human intervention, all vehicle operation functions at least as well as or better than human drivers. Autonomous cars that

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Evolving Trends, *in* 1 MINING IN THE 21ST CENTURY: QUO VADIS? 35, 47–48 (A.K. Ghose & L.K. Bose eds., 2003); Press Release, Rio Tinto Improves Productivity Through the World's Largest Fleet of Owned and Operated Autonomous Trucks (June 9, 2014), *available at* http://www.riotinto.com /media/media-releases-237_10603.aspx. The mining truck Rio Tinto claims to be "autonomous" is in fact operated by remote control. *See* Press Release, Rio Tinto, *supra*.

25. FED. R.R. ADMIN., U.S. DEP'T OF TRANSP., REMOTE CONTROL LOCOMOTIVE OPERATIONS: RESULTS OF FOCUS GROUPS WITH REMOTE CONTROL OPERATORS IN THE UNITED STATES AND CANADA 8 (2006).

26. Bryant Walker Smith, *Automated Vehicles Are Probably Legal in the United States*, 1 TEX. A&M L. REV. 411 (2014).

27. *Self-Driving Cars and Insurance*, INS. INFO. INST. (Feb. 2015), http://www.iii.org/issue-update/self-driving-cars-and-insurance.

operate without human drivers will require more than new technologies. They will also require revised legal requirements and important policy determinations.

II. DIFFERENCES BETWEEN AUTOMATED AND AUTONOMOUS CARS

Terminology applied to autonomous vehicles can obscure important policy choices that will need to be made about the first generation of autonomous cars. Autonomous vehicles that operate without the intervention of a human driver are sometimes described as "self-driving" or "driverless."[28] Autonomous passenger cars will be a sub-part of a more general autonomous vehicles category, which can encompass a variety of applications. For example, autonomous vehicles can be used for personal mobility, commercial, transit, military, industrial, or other purposes, provided that the vehicle is entirely operated by artificial intelligence within the vehicle.[29] An autonomous vehicle may be a truck, a bus, or some other mode of motorized ground transportation, in addition to the passenger cars, which are the focus of this discussion.

Unfortunately, over the past few years "autonomous" has also been used to describe varied applications of automated vehicle systems, from electronic stability control to automatic lane keeping systems. Common parlance also uses "autonomous" to refer to part-time operation of vehicles by intelligent systems capable of independently controlling some or all vehicle operations for part of a journey, or in specific roadway contexts. Examples of these not-fully-autonomous vehicle technologies include the General Motors "Super Cruise"[30] and Tesla's promised "Autopilot."[31] Both of these automotive technologies are variously promoted as autonomous or semi-autonomous features, although at all times a human

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28. Google, for example, refers to its autonomous vehicle project as the "Self-Driving Car Project." GOOGLE SELF-DRIVING CAR PROJECT, https://plus.google.com/+GoogleSelfDrivingCars/ (last visited Mar. 31, 2015).

29. *See, e.g.*, PELOTON TECH., *supra* note 19; Vijayenthiran, *supra* note 3.

30. Jerry Hirsch, *GM Will Introduce Hands-Free, Foot-Free Driving in 2017 Cadillac*, L.A. TIMES (Sept. 7, 2014, 1:35 PM), http://latimes.com/business/autos/la-fi-hy-gm-cadillac-super-cruise-20140907-story.html.

31. Christopher DeMorro, *Elon Musk: Tesla Capable of "90% Autopilot" By Next Year*, CLEANTECHNICA (Oct. 7, 2014), http://cleantechnica.com/2014/10/07/elon-musk-tesla-capable-90-autopilot-next-year/.

driver is required to be present and capable of taking operational control of vehicles with these features.[32] Such automated vehicle functions and limited self-operating capacities are worthwhile developments; but they do not make human-driven automated vehicles having these or other automated features truly autonomous in the sense used in this Article.

The first generation of fully autonomous cars will provide personal mobility without human operational control at all stages of the car's travel. These autonomous cars will rely entirely on computerized systems and controls. The legal and policy issues posed by such an autonomous car are challenging.

A. AUTOMATED VEHICLE LEVELS

Currently, "autonomous" as applied to vehicles is sufficiently ambiguous that standard-setting and regulatory bodies have avoided using it in scoping the development of automated vehicle technologies, some of which will be used in the first generation of autonomous cars. In fact, there are two different versions of development stages through which vehicles will pass on their way to becoming autonomous (i.e., complete control of all driving functions at all times).

First, NHTSA suggested vehicle automation levels in the agency's 2013 *Preliminary Statement of Policy Concerning Automated Vehicles*.[33]

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32. *Id.*; Hirsch, *supra* note 30.

33. NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP'T OF TRANSP., PRELIMINARY STATEMENT OF POLICY CONCERNING AUTOMATED VEHICLES (2013) [hereinafter NHTSA PRELIMINARY STATEMENT], *available at* http://www.nhtsa.gov/staticfiles/rulemaking/pdf/Automated_Vehicles_Policy.pdf.

Table 1: NHTSA Levels of Automation

Level 0: No Automation	"The driver is in complete and sole control of the primary vehicle controls (brake, steering, throttle, and motive power) at all times, and is solely responsible for monitoring the roadway and for safe operation of all vehicle controls. Vehicles that have certain driver support/convenience systems but do not have control authority over steering, braking, or throttle would still be considered 'level 0' vehicles . . . ."
Level 1: Function-Specific Automation	"Automation at this level involves one or more specific control functions; if multiple functions are automated, they operate independently from each other. The driver has overall control, and is solely responsible for safe operation, but can choose to cede limited authority over a primary control (as in adaptive cruise control), the vehicle can automatically assume limited authority over a primary control (as in electronic stability control), or the automated system can provide added control to aid the driver in certain normal driving or crash-imminent situations (e.g., dynamic brake support in emergencies). The vehicle . . . does not replace driver vigilance and does not assume driving responsibility from the driver. The vehicle's automated system may assist or augment the driver in operating one of the primary controls – either steering or braking/throttle controls (but not both) . . . ."
Level 2: Combined Function Automation	"This level involves automation of at least two primary control functions designed to work in unison to relieve the driver of control of those functions. Vehicles at this level of automation can utilize shared authority when the driver cedes active primary control in certain limited driving situations. The driver is still responsible for monitoring the roadway and safe operation and is expected to be available for control at all times and on short notice. The system can relinquish control with no advance warning and the driver must be ready to control the vehicle safely . . . ."
Level 3: Limited Self-Driving Automation	"Vehicles at this level of automation enable the driver to cede full control of all safety-critical functions under certain traffic or environmental conditions and in those conditions to rely heavily on the vehicle to monitor for changes in those conditions requiring transition back to driver control. The driver is expected to be available for occasional control, but with sufficiently comfortable transition time . . . ."
Level 4: Full Self-Driving Automation	"The vehicle is designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip. Such a design anticipates that the driver will provide destination or navigation input, but is not expected to be available for control at any time during the trip. This includes both occupied and unoccupied vehicles. By design, safe operation rests solely on the automated vehicle system."

Second, SAE International developed a somewhat different and more intricate set of progressive levels of vehicle automation in its Information Report J3016 on levels of driving automation for on-road vehicles.[34]

Table 2: SAE Levels of Automation

Level 0: No Automation	"[T]he full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems"
Level 1: Driver Assistance	"[T]he driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task"
Level 2: Partial Automation	"[T]he driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task"
Level 3: Conditional Automation	"[T]he driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene"
Level 4: High Automation	"[T]he driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene"
Level 5: High Automation	"[T]he full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions"

The two versions of vehicle automation levels are similar, but their levels differ in number, and are described somewhat differently. In both versions, autonomous vehicles are at the highest level of automation. Under the SAE five-level scheme of automation, autonomous cars that are the subject of this Article would fit in the top category, Full Automation, Level 5:

> [T]he full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver.[35]

NHTSA's slightly different four levels of automation also place autonomous cars at the highest level of vehicle automation, Full Self-Driving Automation, Level 4:

> The vehicle is designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip. Such a

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34. SAE INT'L, AUTOMATED DRIVING: LEVELS OF DRIVING AUTOMATION ARE DEFINED IN NEW SAE INTERNATIONAL STANDARD J3016 (2014), *available at* http://www.sae.org/misc/pdfs/automated_driving.pdf.

35. *Id.*

> design anticipates that the driver will provide destination or navigation input, but is not expected to be available for control at any time during the trip. This includes both occupied and unoccupied vehicles. By design, safe operation rests solely on the automated vehicle system.[36]

Existing vehicle automation has reached Level 2 and is moving into Level 3 under the SAE categories. Under the NHTSA automation levels, currently available automation technologies are also at Level 2, and moving into Level 3. In neither system are existing automated technologies close to the top level of fully autonomous operation.

It is possible that lower-level, highly-automated vehicles capable of temporary autonomous operation in limited circumstances may be sufficient for many car purchasers for quite some time. There may turn out to be consumer market inertia at lower levels of vehicle automation, where consumers are comfortable with considerable driver assistance and driver warnings, but still want to drive their own cars, instead of being driven by them. Car buyers whose adolescence was culminated by acquiring a driver's license may not be as eager to leave car operation to the car. As a result, it may take many years for first generation fully autonomous cars to penetrate consumer passenger car markets in significant numbers. It also seems possible that some of this market demand inertia will reflect legal uncertainties and risks that would be avoided by automated vehicles that retain a human driver in the control and responsibility loops. Before the first generation of autonomous vehicles becomes widespread as a consumer choice, a new generation of car purchasers will need to come on the scene and a significant amount of legal reform will need to occur.

In addition to psychological reluctance to relinquish control over mobility, the legal consequences of having no human driver in control, or potential control, of a passenger car are pervasive. In the legal system, there is a sharp divide between very highly automated cars with drivers and autonomous cars in which human drivers will have no role. In some areas of law, such as vehicle regulation and insurance, first generation autonomous cars may require entirely new specialized legal regimes. In other areas of law, such as civil liability, the gradual adaptation by the legal ecosystem to partially-

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36. NHTSA PRELIMINARY STATEMENT, *supra* note 33.

automated or part-time autonomous vehicles will help to pave the way for legal changes that will be necessary before the first generation autonomous cars are permitted to operate on United States roadways.

III. AUTONOMOUS CAR TECHNOLOGIES

Interaction among several types of technologies will enable first generation autonomous cars to operate on public roads without operational control by human drivers. A useful way to look at autonomous vehicle technologies is to start with the interface between humans and autonomous vehicles, then at two types of data input technologies, then the automated controls over vehicle functions, and finally at the artificial intelligence technologies that integrate data input and determine when and how to activate automated vehicle controls. Five groups of technologies combine to operate an autonomous car: (1) human-vehicle interface; (2) sensors that provide data about operation of vehicle and its parts; (3) sensors that provide data about the external roadway environment, including Connected Vehicle or other real-time sources of dynamic data about the area around a vehicle; (4) automated controls over vehicle operations and functions; and (5) artificial intelligence that integrates in-vehicle operational data with external roadway data and uses it to activate automated vehicle controls. Each of these groups of vehicle technologies is challenging to the legal system in different ways. The integrated application of these technologies in operating a fully autonomous car poses additional issues.

A. HUMAN-VEHICLE INTERFACE

The points at which a human user interacts with an autonomous car will be crucial in determining legal responsibility. These interaction points are called human-machine interfaces (HMIs).[37] It is likely that the first generation of autonomous cars will involve HMIs that provide no choices other than to use the autonomous vehicle or not to use it. That interface may take the form of a fob, a push-button, a biometric sensor, or other on-off control. In some jurisdictions, when a human person turns on an autonomous

37. TIM SMITH ET AL., USTWO, ARE WE THERE YET? THOUGHTS ON IN-CAR HMI 2 (2014), http://cdn.ustwo.com/automotive/AreWeThereYet_V1.0.pdf.

vehicle, the human becomes the "operator" of the autonomous vehicle.[38]

More advanced interactions between humans and autonomous cars than a simple binary choice (on or off) could also be available in the first generation of fully autonomous cars. For example, in addition to switching on, or activating, an autonomous vehicle, the human may be able to fine-tune in advance how the autonomous vehicle is expected to operate. Initially, the choices are likely to be simple. For example, there might be "operational options" such as "get there fastest," "leisurely," "scenic roads," or "<specified time of arrival>." These options technically refer to specific ways in which an autonomous car could be programmed to operate. Eventually, idiosyncratic styles of autonomous vehicle operation could be programmed to provide an array of user choices that would cause an autonomous car to operate in various ways that uniquely respond to individual user preferences. With increased human choices will come responsibility, including legal responsibility.[39]

B. SENSORS COLLECTING INTERNAL VEHICLE OPERATION DATA

Sensors that detect and process the operation of various parts within a vehicle, such as the brakes, transmission, and steering, are already embedded in all modern vehicles.[40] Thousands of sensor microprocessors communicate over the Controller Area Network (CAN) bus—under International Organization for Standardization (ISO) 11898 standards—for vehicle coordination, diagnostic, and other purposes.[41] The

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38. *See, e.g.*, FLA. STAT. ANN. § 316.85 (West 2014) ("[A] person shall be deemed to be the operator of an autonomous vehicle operating in autonomous mode when the person causes the vehicle's autonomous technology to engage, regardless of whether the person is physically present in the vehicle while the vehicle is operating in autonomous mode.").

39. It seems likely that the very first generation of autonomous cars will be programmed by the manufacturer in standard ways. That manufacturer programming would lead to product liability if the programming malfunctions. *See infra* Part V.B.1.

40. Robert N. Charette, *This Car Runs on Code*, IEEE SPECTRUM (Feb. 1, 2009, 5:00 PM), http://spectrum.ieee.org/transportation/systems/this-car-runs-on-code.

41. INT'L ORG. FOR STANDARDIZATION, ROAD VEHICLES—CONTROLLER AREA NETWORK (CAN)—PART 1: DATA LINK LAYER AND PHYSICAL SIGNALING 1–3 (2003), *available at* https://www.iso.org/obp/ui/#iso:std:iso:11898:-1:ed-1:v1:en. "The CAN bus was developed . . . as a multi-master, message broadcast

capacities and configurations of these sensors are generally proprietary information closely held by vehicle manufacturers, partly for reasons of competitive advantage.[42] Because these internal sensors function as evaluators of the internal mechanical state and operation of a vehicle and its parts, their functionality can have significant legal consequences in terms of isolating vehicle malfunctions. So far, published literature does not separately address autonomous vehicle applications of this technology with any specificity. In fact, these sensor systems appear to be protected as copyrighted computer code and closely guarded trade secrets.[43]

C. SENSORS PROVIDING LOCATION AND EXTERNAL ROADWAY ENVIRONMENT DATA

Global Positioning Systems (GPS) that provide real-time location information are a nearly universal feature of experimental autonomous cars.[44] However, because the resolution of ordinary GPS signals is only accurate to a level of 3.5 meters, augmentation (such as through differential GPS) is required if it is necessary to locate an autonomous vehicle within a few centimeters.[45] In addition to GPS, other sources of

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system . . . . Unlike a traditional network such as USB or Ethernet, CAN does not send large blocks of data . . . . In a CAN network, many short messages like temperature or RPM are broadcast to the entire network, which provides for data consistency in every node of the system." STEVE CORRIGAN, TEX. INSTRUMENTS, INTRODUCTION TO THE CONTROLLER AREA NETWORK (CAN) 2 (2008), *available at* http://www.ti.com/lit/an/sloa101a/sloa101a.pdf.

42. *See* Michael Porter & James Heppelmann, *How Smart, Connected Products Are Transforming Competition*, HARV. BUS. REV. (Nov. 2014), https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition. Other reasons include defense in product liability lawsuits, product analysis and improvement, customer service, and other corporate purposes.

43. *Id.*; *see* Kyle Wiens, *We Can't Let John Deere Destroy the Very Idea of Ownership*, FORBES (May 21, 2015, 9:00 AM), http://www.wired.com/2015/04/dmca-ownership-john-deere/ (describing controversy over copyright protection of vehicle computer programming before the United States Copyright Office).

44. Greg Kogut, *Sensors*, *in* AUTONOMOUS TECHNOLOGIES: APPLICATIONS THAT MATTER 1, 11 (William C. Messner, ed. 2014).

45. Dan Williams, *Cargo and Freight*, *in* AUTONOMOUS TECHNOLOGIES: APPLICATIONS THAT MATTER, *supra* note 44, at 60 (discussing how "[c]urrent GPS functionality lacks fidelity required for precise . . . positioning"); *see GPS Accuracy*, GPS.GOV, http://www.gps.gov/systems/gps/performance/accuracy/ (last modified September 18, 2014) (noting that accuracy better than 3.5 meters requires augmentation); *GPS Augmentation*, GPS.GOV, http://www.gps.gov/systems/augmentations/ (last modified January 29, 2014).

precise location information mostly come from dynamic digital mapping.[46] Most experimental autonomous cars appear to rely on digital maps as one source of roadway location data.[47] Because autonomous cars require exact location awareness for safe operation, precise mapping, tracking and other "environmental awareness" technologies used by autonomous cars appear to be improving.[48]

Developers of experimental autonomous cars have created innovative sensors that collect data about what is happening in the roadway environment through which an autonomous vehicle is moving.[49] Indeed, autonomous car developers, such as Google, have invented a variety of different types of sensors.[50] Because a robust "picture" of the immediate and farther away roadway environment requires multiple sources of data about the roadway, multiple forms of radar, LIDAR, infrared, sonar, and optics are deployed in experimental versions of autonomous cars.[51] In first generation autonomous cars, multiple sensors will operate as redundant sources of roadway data.[52] Because poor weather conditions, such as snow or heavy rain, interfere with sensors that rely on line-of-sight, even redundant arrays of multiple sensors may fail to provide adequate roadway environment input for autonomous cars in some types of weather.[53]

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46. Greg Miller, *Autonomous Cars Will Require a Totally New Kind of Map*, WIRED (Dec. 15, 2014, 6:45 AM), http://www.wired.com/2014/12/nokia-here-autonomous-car-maps.

47. *See id.*

48. PIERRE LAMON, ET AL., MAPPING WITH AN AUTONOMOUS CAR (2006), *available at* http://www2.informatik.uni-freiburg.de/~plagem/bib/lamon06iros.pdf; Vince Bond Jr., *Up-To-The-Minute Maps Will Be Critical for Autonomous Cars*, AUTOMOTIVE NEWS (Sept. 13, 2014, 12:01 AM), http://www.autonews.com/article/20140913/OEM06/309159962/up-to-the-minute-maps-will-be-critical-for-autonomous-cars; Miller, *supra* note 46.

49. Richard Bishop, *Automated Driving: For Real This Time?*, *in* AUTONOMOUS TECHNOLOGIES: APPLICATIONS THAT MATTER, *supra* note 44, at 15, 21 (discussing various "sensing technolog[ies]" that support autonomous vehicles); Kogut, *supra* note 44, at 1–13.

50. Kogut, *supra* note 44, at 1–13, fig.1.8.

51. *Id.* at 6–10.

52. *Id.* at 13 ("[N]o single sensor will be a 'silver bullet' for autonomy. Rather, each sensor will contribute and complement the data from the others, producing a rich picture of the vehicle and the surrounding environment.").

53. *See id.* at 10 (discussing the weakness of certain sensor systems in "some environmental conditions, particularly rain and snow"); Doron Levin, *The Cold, Hard Truth About Autonomous Vehicles and Weather*, FORTUNE

As a result, it is likely that additional data input will probably be needed to supply roadway situational information to first generation autonomous cars. Infrastructure data about curves, intersections or bridge abutments may be provided by beacons or enhanced reflectors of vehicle signals. However, some additional data inputs will probably come from wireless communications technologies that are not sensors, but provide vital data about a vehicle's driving environment. The exact nature of the wireless systems that will provide external data input for autonomous cars is uncertain at this time. Wireless communication of data, such as dynamic traffic flows around vehicles, is bound up in controversies over the United States Department of Transportation's Connected Vehicle program discussed in Part IV below.

D. AUTOMATED CONTROLS OVER VEHICLE FUNCTIONS AND OPERATION

In an autonomous vehicle, control over vehicle operation and direction is automated through networks of actuator microprocessors triggered by the vehicle's artificial intelligence, discussed below in Part III.E. So far, automated controls appear remarkably reliable in accomplishing designated vehicle operations. However, some automated controls appear more dependable than others. For example, lane-keeping controls[54] have proved less reliable than electronic stability control.[55] Technical developments regarding automated vehicle

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(Feb. 2, 2015, 5:10 PM), http://fortune.com/2015/02/02/autonomous-driving-bad-weather/.

54. DONALD A. NORMAN, THE DESIGN OF FUTURE THINGS 91, 109 (Basic Books 2009) ("Lane-keeping is not (yet) completely reliable . . . ."). *See generally* Chad Kirchner, *Lane Keeping Assist Explained*, MOTOR REV. (Feb. 17, 2014), http://motorreview.com/lane-keeping-assist-explained/ ("The vehicle, whether or not the driver is interacting or not, stays in the lane it is currently in. There are several ways the vehicle goes about performing this task, and some manufacturers take a slightly different approach to implementation, but the concept remains the same.").

55. NORMAN, *supra* note 54, at 5 ("[S]tability systems actually perform far better than all but the most expert drivers."). *See generally Electronic Stability Control*, SAFERCAR.GOV, http://www.safercar.gov/Vehicle+Shoppers/Rollover/Electronic+Stability+Control (last visited Feb. 18, 2015) ("Electronic Stability Control (ESC) uses automatic braking of individual wheels to prevent the heading from changing too quickly (spinning out) or not quickly enough (plowing out). ESC cannot increase the available traction, but maximizes the possibility of keeping the vehicle under control and on the road during

controls, as well as public confidence in automated vehicle controls, will pose technical as well as legal challenges. Moreover, automated controls appear to be the most vulnerable aspect of vehicle automation to car hacking.[56] The vulnerability of such automated controls over vehicle function in first generation autonomous cars will be discussed further in relation to security aspects of autonomous cars, *infra*, Part V.E.

E. ARTIFICIAL INTELLIGENCE

An autonomous car will rely on highly sophisticated computer processing to integrate and analyze internal vehicle operational data and roadway sensor data and then to determine which automated controls to activate and trigger them. Artificial intelligence integrates internal vehicle operational and external roadway environment inputs described in Parts III.B and C. That analytic function occurs prior to actuating automated vehicle controls, which simultaneously provide feedback data to the system.[57] So far, sufficient computational power to manage autonomous vehicle data integration, analysis, and activation appears to be available.[58] However, capacities for vehicle system data fusion and control architecture are not unlimited. Since a first generation autonomous car's artificial intelligence will be tasked with management functions otherwise performed by a human driver, the intelligence needs to be at least as accurate and reliable as human intelligence.[59]

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extreme maneuvers by using the driver's natural reaction of steering in the intended direction.").

56. *See infra* Part V.E.

57. INT'L TRANSP. FORUM, ORG. FOR ECON. COOPERATION & DEV., AUTOMATED AND AUTONOMOUS DRIVING: REGULATION UNDER UNCERTAINTY 11–12 (2015), *available at* http://www.internationaltransportforum.org/pub/pdf/15CPB_AutonomousDriving.pdf.

58. *Programming Safety into Self-Driving Cars*, NAT'L SCI. FOUND. (Feb. 2, 2015) http://www.nsf.gov/discoveries/disc_summ.jsp?cntn_id=134033&org=IIS (introducing algorithms designed to incorporate adequate safety controls in semi-autonomous vehicles).

59. Will Knight, *Driverless Cars Are Further Away Than You Think*, MIT TECH. REV. (Oct. 22, 2013), http://www.technologyreview.com/featuredstory/520431/driverless-cars-are-further-away-than-you-think/; *see* Bishop, *supra* note 49, at 37 (setting the goal for autonomous vehicles as "better than human driving").

F. MANUFACTURING APPROACHES

Existing vehicle manufacturers may manufacture complete autonomous vehicles, including all of their parts and systems. However, it seems more likely that component manufacturers will make specific parts or components that vehicle manufacturers will integrate into autonomous cars.[60] Specialized technology companies such as Bosch and Continental are already developing autonomous and automated vehicle modules.[61] Such specialized technology companies could also develop components or modules that would permit conventional vehicles to be converted to autonomous cars. Although the latter manufacturing strategy could transform a wide range of conventional cars into autonomous cars, the first generation autonomous cars are likely to be original equipment.[62]

Some vehicle manufacturers, such as Tesla, currently control distribution of their conventional vehicles and do not sell through car dealers.[63] A similar pattern of combined manufacture and sale of autonomous cars seems likely because of the probable need for continuing software and mapping downloads.

IV. FIRST GENERATION AUTONOMOUS CARS MAY OR MAY NOT BE CONNECTED VEHICLES

First generation autonomous cars may or may not rely on connected vehicle technologies, some of which are already available in conventional cars.[64] Whether first generation

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60. *E.g.*, Gabe Nelson, *Google in Talks With OEMs, Suppliers to Build Self-Driving Cars*, AUTO. NEWS (Jan. 14, 2015, 2:10 PM), http://www.autonews.com/article/20150114/OEM09/150119815/google-in-talks-with-oems-suppliers-to-build-self-driving-cars.

61. Stephen Edelstein, *Bosch Expects to See Self-Driving Cars in 10 Years*, DIGITAL TRENDS (Jan. 20, 2015), http://www.digitaltrends.com/cars/bosch-expects-see-self-driving-cars-10-years/; Joseph Szczesny, *Continental Ups the Autonomous Car Ante*, DETROIT BUREAU (Aug. 18, 2014), http://www.thedetroitbureau.com/2014/08/continental-ups-the-autonomous-car-ante/.

62. Embedded electrical and security systems may, as a practical matter, require building the first commercially available cars "from scratch."

63. This manufacture-sales combination that involves selling vehicles without dealers is called "disintermediation." *See* Porter & Heppelmann, *supra* note 42.

64. Office of the Assistant Sec'y for Research & Tech., *Connected Vehicle Technology: Safety Pilot Driver Acceptance Clinics and Model Deployment Overview*, U.S. DEP'T TRANSP., http://www.its.dot.gov/research/safety_pilot

autonomous cars will use these or other types of connected vehicle technologies remains unknown, partly because it is uncertain what "connected vehicles" means. Experimental autonomous cars have been designed to avoid connection with any external source of information.[65] For example, the DARPA Challenges did not permit autonomous vehicle competitors to rely on external wireless connections during qualifying events.[66] Initial designs for the Google Car also avoided use of wirelessly communicated information, aside from GPS.[67] As a result, connected vehicle systems appear not to be an essential aspect of first generation autonomous cars.

Whether, as a policy matter, autonomous cars should be wirelessly connected is the most general of several policy determinations about autonomous car connections that have not yet been made. Even if autonomous cars are required to be connected vehicles, there remain difficult issues with regard to whether autonomous car connections should be restricted to data exchanges with other vehicles (V2V) as opposed to communicating more generally to other wireless recipients. These policy questions raise distinct and quite complicated issues. Conflating these complicated issues into an indeterminate concept called "connected vehicles" makes resolving them much more difficult. Inability to resolve these connected vehicle issues could delay the entry of first generation autonomous vehicles onto the roads of the United States.

_overview.htm (last updated Jan. 22, 2015, 9:50 AM) [hereinafter *USDOT Connected Vehicle Technology Safety Pilot*] ("Connected vehicles that communicate with each other as well as with traffic lights, work zones and other infrastructure have the potential to address more than 80 percent of unimpaired driver crashes, according to the National Highway Traffic Safety Administration (NHTSA).").

65. *See* Dorothy J. Glancy, *Privacy in Autonomous Vehicles*, 52 SANTA CLARA L. REV. 1171, 1173–78 (2012) (outlining suggested categories of self-contained, as opposed to interconnected, autonomous vehicles).

66. DEF. ADVANCED RESEARCH PROJECTS AGENCY, URBAN CHALLENGE: RULES 11 (2007), *available at* http://archive.darpa.mil/grandchallenge/docs/Urban_Challenge_Rules_102707.pdf ("Any wireless system used for vehicle movement or testing must be disconnected or disabled . . . .").

67. Erico Guizzo, *How the Google's Self-Driving Car Works*, IEEE SPECTRUM (Oct. 18, 2011), http://spectrum.ieee.org/automaton/robotics/artificial-intelligence/how-google-self-driving-car-works.

A. CONNECTED VEHICLE ALTERNATIVES

Vehicles may be physically, virtually, or otherwise connected in a wide variety of ways. Autonomous vehicles will be considered connected vehicles to the extent that they are equipped to send or receive information over wireless communications channels. However, that concept is too imprecise to enable policy determinations about whether the first generation of autonomous cars should be connected. The types of connections matter.

USDOT has fostered confusion about connected vehicles by using the concept in several different senses. The Connected Vehicle Program within USDOT considers a number of different modes and types of wireless connectivity.[68] At present, USDOT divides connected vehicles into two main categories of connected vehicle technologies: (1) Connected Vehicle Safety Systems that use Dedicated Short Range Communications (DSRC) transceivers to send and receive vehicle data,[69] and (2)

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68. Office of the Assistant Sec'y for Research & Tech., *Connected Vehicle Technology*, U.S. DEP'T TRANSP., http://www.its.dot.gov/landing/cv.htm (last updated Feb. 11, 2015, 9:05 AM). The program is now managed by the Office of Research and Technology within the Office of the Secretary of Transportation. Greg Winfree, *RITA Becomes Office of Research and Technology*, U.S. DEP'T TRANSP. (Jan. 30, 2014), http://www.dot.gov/fastlane/rita-becomes-office-research-and-technology. In addition, the Federal Highway Administration and NHTSA work with implementing aspects of Connected Vehicles. *Regulation & Policy*, FED. HIGHWAY ADMIN., U.S. DEP'T TRANSP., http://ops.fhwa.dot.gov/travelinfo/resources/policy.htm (last modified July 30, 2014); *Vehicle-to-Vehicle Communications*, NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., http://www.safercar.gov/v2v/index.html (last visited Feb. 18, 2015).

69. Office of the Assistant Sec'y for Research & Tech., *Dedicated Short Range Communications: Overview of Dedicated Short Range Communications (DSRC) Technology*, U.S. DEP'T TRANSP., http://www.its.dot.gov/DSRC/ (last updated Dec. 5, 2014, 1:55 PM). DSRC technologies were developed under the auspices of USDOT's Intelligent Transportation Systems Joint Program Office. Office of the Assistant Sec'y for Research & Tech., *About ITS: ITS Joint Program Office*, U.S. DEP'T TRANSP., http://www.its.dot.gov/its_jpo.htm (last updated Jan. 22, 2015, 9:50 AM). For more than a decade it has been assumed that connected vehicles in the United States would rely on DSRC transmissions for safety information. *See* Office of the Assistant Sec'y for Research & Tech., *ITS Research Fact Sheets: DSRC: The Future of Safer Driving*, U.S. DEP'T TRANSP., http://www.its.dot.gov/factsheets/dsrc_factsheet.htm (last updated Dec. 5, 2014, 1:55 PM) ("V2V and V2I applications utilizing DSRC may have the potential to significantly reduce many of the most deadly types of crashes through real time advisories alerting drivers to imminent hazards—such as veering close to the edge of the road; vehicles suddenly stopped ahead; collision paths during merging; the presence of

Connected Vehicle Mobility Applications, which generally use cellular wireless to send and receive a wide range of data, from the status of the vehicle to navigation assistance and infotainment.[70] In addition, USDOT's Connected Vehicle Program has developed a Core System intended to integrate various types of connected vehicle communications: DSRC communications (V2V, V2I, and V2X) as well as other wireless modes.[71]

At the same time, NHTSA, within USDOT, uses "connected vehicles" in a much more narrow sense that refers only to DSRC V2V technologies.[72] Indeed, NHTSA has announced that it intends to require DSRC technologies as mandatory safety equipment in all new passenger cars and light trucks in the United States.[73] If such a requirement were

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nearby communications devices and vehicles; sharp curves or slippery patches of roadway ahead.").

70. *See* CHRISTOPHER HILL, MODULE 13: CONNECTED VEHICLES 1–2 (2013), *available at* http://www.pcb.its.dot.gov/eprimer/documents/module 13.pdf ("Non-safety [connected vehicle] applications may be based on different types of wireless technology."). The infotainment category includes both cellular wireless and satellite transmission such as SiriusXM Satellite Radio. *See* SIRIUSXM, http://www.SiriusXM.com (last visited Feb. 20, 2015).

71. Office of the Assistant Sec'y for Research and Tech., *Connected Vehicle Core System Baseline Documentation*, U.S. DEP'T TRANSP., (last updated Dec. 5, 2014, 1:55 PM), http://www.its.dot.gov/press/2011/connected_vehicle_core system_docs.htm. Only a general concept of a Core System has been developed, describing operations with a high-level, multi-platform design that "use various means of [vehicle] communications technology," and will use "new and updated standards." *Id.*

72. NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP'T OF TRANSP., VEHICLE-TO-VEHICLE COMMUNICATIONS: READINESS OF V2V TECHNOLOGY FOR APPLICATION xiii (2014) [hereinafter NHTSA V2V READINESS], *available at* http://www.nhtsa.gov/staticfiles/rulemaking/pdf/V2V/Readiness-of-V2V-Technology-for-Application-812014.pdf ("The United States Department of Transportation and NHTSA have been conducting research on this technology for more than a decade.").

73. Federal Motor Vehicle Safety Standards: Vehicle-to-Vehicle (V2V) Communications, 79 Fed. Reg. 49,270, 49,272 (proposed Aug. 20, 2014) (to be codified at 49 C.F.R. pt. 571) (outlining plans to "require vehicle-to-vehicle (V2V) communication capability for light vehicles (passenger cars and light truck vehicles (LTVs)) and to create minimum performance requirements for V2V deceives and messages"); *see* MICH. DEP'T TRANSP. & CTR. FOR AUTOMOTIVE RESEARCH, CONNECTED VEHICLE TECHNOLOGY INDUSTRY DELPHI STUDY 4 (2012), *available at* http://www.cargroup.org/assets/files/mdot /mdot_industry_delphi.pdf ("Regarding the possible 2013 NHTSA Notice of Regulatory Intent on mandating V2V safety systems for vehicles, most respondents expressed the view that NHTSA will announce that it does intend to mandate V2V safety. Respondents further indicated that, if this proves to

adopted, DSRC would become mandatory standard safety equipment in first generation autonomous cars, but not required in other types of vehicles, such as heavy trucks and buses.

Several recent challenges (some legal) reflect potential problems with NHTSA's potential near-term requirement of DSRC-based data transmissions to and from first generation autonomous cars. First, the wireless spectrum allocated for DSRC may not be useable.[74] The Federal Communications Commission may reallocate parts of the now-dedicated 5.9 GHz DSRC spectrum to other types of wireless users.[75] Interference from other, non-vehicle uses of DSRC's wireless spectrum could so degrade the reliability of DSRC real time vehicle communications that these long-planned Vehicle-to-Vehicle (V2V) communications may, particularly in congested urban areas, become insufficiently reliable for use by first generation autonomous cars.[76]

In addition, concerns about security and personal privacy, as well as surveillance, through DSRC networks have raised policy objections to requiring DSRC data exchanges only among passenger cars and light trucks—the types of vehicles primarily used for personal mobility by individuals.[77] These privacy and surveillance concerns have been compounded by

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be correct, by 2022 all new vehicles sold in the U.S. will be required to have V2V communication equipment as standard equipment.").

74. Since 1999, seventy-five MHz of spectrum from 5.850 to 5.925 GHz (usually referred to as the 5.9 GHz spectrum) has been reserved solely for vehicle safety and mobility communications in the form of DSRC. Amendment of Parts 2 and 90 of the Commission's Rules to Allocate the 5.850–5.925 GHz Band to the Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Services, 14 FCC Rcd. 18221 (Oct. 21, 1999).

75. Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band, 28 FCC Rcd. 1769 (Feb. 20, 2013); *see* REBECCA BLANK & LAWRENCE E. STRICKLING, U.S. DEP'T OF COMMERCE, EVALUATION OF THE 5350–5470 MHZ AND 5850–5925 MHZ BANDS PURSUANT TO SECTION 6406(B) OF THE MIDDLE CLASS TAX RELIEF AND JOB CREATION ACT OF 2012 (2013), *available at* http://www.ntia.doc.gov/files/ntia/publications/ntia_5_ghz_report_01-25-2013.pdf.

76. *Safety and Connected Vehicles: The Connected Vehicle – Crash Avoidance and the Benefits to Transportation Safety, Mobility and the Economy*, ITS AM., http://www.itsa.org/advocacy/safety-and-connected-vehicles- (last visited Feb. 22, 2015).

77. *See* NHTSA V2V READINESS, *supra* note 72, at 58 ("For the question of public acceptance, the main concerns with regard to a DSRC [Federal Motor Vehicle Safety Standard] likely relate to security and privacy.").

reservations regarding the security of unencrypted V2V operating data.[78] Moreover, since no federal statute expressly authorizes, much less directs, NHTSA to adopt such a requirement that a DSRC transceiver must be embedded in every new passenger vehicle and light truck, there are legal objections to NHTSA's statutory authority to adopt the DSRC connected vehicle mandate.[79] Because the development of DSRC has taken more than a decade, some technology experts view DSRC as outdated technology that should be reassessed in light of newer and potentially better communications technology.[80] Although existing alternative communications technologies are not now quick enough (i.e., lack the low latency of DSRC) to provide split-second warnings about impending dangers to moving vehicles,[81] the speed of wireless communications technologies has been improving rapidly.[82]

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78. *Id.* at 153 (outlining "privacy risks into the V2V system, including . . . collection, transmittal, storage, and potential uses of unencrypted GPS and related path history information").

79. Jenna Greene, *Car Talk: Sharp Turns Ahead*, NAT'L L.J. (Dec. 1, 2014), http://www.nationallawjournal.com/id=1202677551065/Car-Talk-Sharp-Turns-Ahead; NHTSA V2V READINESS, *supra* note 72, at 33 (discussing the scope of NHTSA's legal authority to mandate such technology).

80. Brad Templeton, *Will Robocars Use V2V at All?*, RoboHub (Feb. 3, 2015), http://www.automotiveitnews.org/articles/share/559041/.

81. *See* NHTSA V2V READINESS, *supra* note 72, at 26 (discussing DRSC V2V and finding that "[t]here are three . . . safety applications that the agency believes are enabled by [DRSC] alone and could not be replicated by any current, known vehicle-resident sensor- or camera- based systems," specifically citing intersection movement assist, left turn assist, and blind spot warning); *id.* at 28 ("The agency believes, based on current technology, that FCW [forward collision warning] systems using radar or cameras cannot provide a warning fast enough for very high speed rear end crashes. V2V, in contrast, has that capability based on its longer range (300 meters). Thus, fatal rear end crashes are one area where we believe V2V can provide some benefits not potentially covered by radar- and camera-based systems.").

82. JAMES M. ANDERSON ET AL., AUTONOMOUS VEHICLE TECHNOLOGY: A GUIDE FOR POLICYMAKERS 77 (2014), *available at* http://www.rand.org/content/dam/rand/pubs/research_reports/RR400/RR443-1/RAND_RR443-1.pdf. At present, commercial wireless is not as suitable as DSRC for transmitting safety-related vehicle data about potential hazards posed by moving vehicles nearby. *See* NHTSA V2V READINESS, *supra* note 72, at 28 ("Other sensors such as radar, lidar, and cameras enable certain safety applications that are viewed by some as alternatives to [DSRC] V2V. While these systems might be more mature than [DSRC] V2V, they also have drawbacks when used alone; a combined or fused system using any of these other sensors along with V2V will take advantage of the benefits of DSRC.").

Commercial mobile wireless networks, already connecting some conventional cars with the Internet, provide potential alternatives to DSRC. In the private sector, there is growing interest in mobile wireless technologies (such as 4G LTE or, in the future, 5G) as ways to transmit vehicle data at speeds sufficient to provide dynamic roadway, weather, and traffic information to autonomous cars.[83] If such alternative communications technologies become available before the first generation autonomous cars are on the road, these and other vehicles may rely on such commercial communications sources for safety data transmissions, instead of DSRC. If safety data from nearby vehicles seems essential for first generation autonomous cars' safe operation, but is not available over DSRC, these alternative safety data sources using mobile wireless networks may be a solution. On the other hand, first generation autonomous cars may not need to operate as connected vehicles at all.

A separate type of wireless communication that connects vehicles takes the form of vehicle manufacturers' closed private wireless networks used to transmit vehicle data between a vehicle's computer system and the vehicle's manufacturer. These closed communication networks are the focus of the 2015 report, *Tracking & Hacking: Security & Privacy Gaps Put American Drivers at Risk*.[84] Such vehicle communications are sometimes called "telematics" or "automotive telematics,"[85]

83. *Vehicle-to-Vehicle Communication Technology Industry Awareness Driven by Driverless Cars; DSRC to be Challenged by 5G in the Next Decade, Says ABI Research*, FIN. MIRROR (Jan. 20, 2015), http://www.financialmirror.com/newsml_story.php?id=32225. *Cf.* Randal O'Toole, *Policy Implications of Autonomous Vehicles*, 758 CATO INST., Sept. 18, 2014, at 1, 5–8, *available at* http://object.cato.org/sites/cato.org/files/pubs/pdf/pa758_1.pdf (noting navigational driving data available from mobile wireless technology through platforms such as Google Maps, Apple Maps, and various weather mobile apps).

84. SEN. ED MARKEY, TRACKING & HACKING: SECURITY & PRIVACY GAPS PUT AMERICAN DRIVERS AT RISK 3 (2015), *available at* http://www.markey.senate.gov/imo/media/doc/2015-02-06_MarkeyReport-Tracking_Hacking_CarSecurity%202.pdf.

85. *The Meaning of Telematics*, GLOBAL TELEMATICS, http://www.globaltelematics.com/telematics.htm (last modified Sept. 10, 2013) ("The word 'telematics' historically—since 1980—has meant the blending of computers and telecommunications. Thus, the Internet is an example of telematics . . . ."). The consulting firm Gartner limits telematics to communications only from vehicles: "Telematics refers to the use of wireless devices and 'black box' technologies to transmit data in real time back to an

although the concept of telematics is at least as vague as the connected vehicles concept. These closed, private vehicle-manufacturer networks collect information about the performance of a vehicle and its parts for diagnostic and product-improvement purposes.[86] The same wireless networks are also used for manufacturer downloads of software updates to advanced, highly automated vehicles.[87]

Information collected by manufacturer private networks also would be valuable to automobile insurance companies, particularly those that promote Usage Based Insurance (UBI).[88] So far, vehicle manufacturers have refused to release highly valuable proprietary information from their private network vehicle connections to insurance companies or to anyone else.[89] As a result, several insurance companies promote drivers' installation of plug-in devices that wirelessly transmit vehicle information from a port located in all modern vehicles to insurance companies.[90] Much of this insurance information reflects driver behavior and internal operation of the vehicles; this is the same personal information that is the focus of the *Tracking & Hacking* report.[91]

B. WHICH, IF ANY, CONNECTED VEHICLE TECHNOLOGIES WILL BE INCORPORATED INTO FIRST GENERATION AUTONOMOUS CARS?

Any of the above types of vehicle connectivity could turn first generation autonomous cars into connected vehicles. First generation autonomous cars will likely need both mapping data and system software updates sent wirelessly to the autonomous cars by their manufacturers. That means some form of manufacturer private network (telematics) will likely provide highly secure data and programming downloads into first

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organization. Typically, it's used in the context of automobiles, whereby installed or after-factory boxes collect and transmit data on vehicle use, maintenance requirements or automotive servicing." *Telematics*, GARTNER, http://www.gartner.com/it-glossary/telematics (last visited Feb. 20, 2015).

86. *See* MARKEY, *supra* note 84.

87. *Id.*

88. *See* Nick Wingfield, *How's My Driving? The Insurer Knows*, N.Y. TIMES (June 10, 2015, 6:27 PM), http://bits.blogs.nytimes.com/2015/06/10/hows-my-driving-the-insurer-knows/.

89. *See* MARKEY, *supra* note 84, at 4.

90. *See* Wingfield, *supra* note 88.

91. *See* MARKEY, *supra* note 84, at 12.

generation autonomous cars. Manufacturers will also want vehicle diagnostic data regarding their newest products. Unless legislation or regulation restricts the use of these networks,[92] this form of connected vehicle technology will probably be included in first generation autonomous cars.

It is also likely that first generation autonomous cars will be connected to wireless systems that provide infotainment as well as Internet and telephone connections.[93] In fact, relieved of all responsibility for driving, users of first generation autonomous vehicles will have more time for watching videos, texting, or surfing the Internet. These wireless connections to vehicles will, of course, also generate privacy and security concerns.[94]

What remains uncertain is whether NHTSA's narrow definition of connected vehicles to include only DSRC V2V communications in passenger cars and light trucks, will be a required feature of first generation autonomous cars. Cooperative vehicle data exchanges are often assumed to be features of autonomous cars. And yet, DSRC connected vehicle technology may not be part of first generation autonomous vehicles. Since this first generation is expected to be on U.S. roads within a decade,[95] that may be well before uncertainties about mandatory DSRC exchanges will have been resolved.

V. LAWS FIRST GENERATION AUTONOMOUS CARS WILL ENCOUNTER

The rules, legislation, and regulation that first generation autonomous cars will encounter will, for the most part, be similar to laws that apply to conventional vehicles already on the road. Most current laws do not discriminate in favor of or against autonomous cars. Nevertheless, some aspects of current laws will have to change before first generation autonomous cars can lawfully operate on public roads in the United States. The sections that follow consider the legal landscape that the first generation of autonomous cars will face as they join conventional vehicles on public roads and

92. Senator Markey's *Tracking & Hacking* report calls for such regulation to protect consumer interests in privacy and security. *See generally id.*

93. *See supra* notes 84–91 and accompanying text.

94. *See infra* text accompanying notes 259–69.

95. *See supra* note 7 and accompanying text.

highways. Beginning with the layered pattern of federal and state laws that will apply to first generation autonomous cars, this Article will discuss the civil and criminal law, insurance law, land use law, as well as privacy and security law that first generation autonomous vehicles will face.

A. FEDERAL AND STATE LEGAL JURISDICTION

Legislative and regulatory jurisdiction over first generation autonomous cars will be divided between the federal government, the states, and local municipalities. Absent preemptive changes in federal law, state law systems will continue to govern most civil and criminal liability issues, and state legislation and administrative regulation will largely govern insurance, land use, and privacy matters. In addition, local government regulation will apply to many of the uses of autonomous cars. In short, first generation autonomous cars will encounter multiple layers of federal, state and local laws, such as:

- Federal legislation and administrative regulation with regard to such matters as highways, vehicle safety and fuel efficiency standards
- State common law with regard to property, tort and contract matters
- State legislation and administrative regulations regarding such matters as minimum vehicle standards, insurance, roadway usage, traffic laws, as well as other issues including privacy, security and environmental regulation
- Local ordinances regarding traffic, pedestrian and bicycle safety and parking

Each of these sources of legal requirements will operate simultaneously and somewhat independently, although federal law can override state law, just as state law can override local law.[96]

In this layered legal environment, federal regulation would likely provide baseline autonomous vehicle safety standards that are usually incorporated into state laws and regulations. For example, if the federal government were to adopt regulations that establish Motor Vehicle Safety Standards for

96. *See* U.S. CONST. art. VI, § 2.

autonomous cars, these federal safety standards would apply nationwide. State laws would incorporate federal standards and also establish further standards for licensing autonomous cars for road use within each state. Once a state permits autonomous cars on state roadways, local ordinances would regulate local autonomous car usage such as parking, speed limits, and the like.

1. Present Legal and Regulatory Situation

At present, the federal government has not enacted national laws governing autonomous cars or other types of autonomous motor vehicles.[97] Within USDOT, NHTSA has general jurisdiction to promulgate regulations that govern the safety of "motor vehicles," defined as vehicles that are "driven or drawn by mechanical power and manufactured primarily for use on public streets, roads, and highways."[98] NHTSA sets safety performance standards for motor vehicles and motor vehicle equipment, such as Federal Motor Vehicle Safety Standards (FMVSS).[99] First generation autonomous cars will have to meet the FMVSS in effect at the time these cars are built or imported. Unless existing FMVSS are changed, first generation autonomous cars will have to comply with FMVSS standards that require a wide range of safety features from bumpers to taillights.[100] These national standards are part of

97. NHTSA PRELIMINARY STATEMENT, *supra* note 33, at 12 ("Particularly in light of the rapid evolution and wide variations in self-driving technologies, we do not believe that detailed regulation of these technologies is feasible at this time at the federal or state level.").

98. 49 U.S.C. § 30102(a)(6) (2012).

99. *See* Federal Motor Vehicle Safety Standards: Vehicle-to-Vehicle (V2V) Communications, 79 Fed. Reg. 49,270, 49,272 (proposed Aug. 20, 2014) (to be codified at 49 C.F.R. pt. 571). *See generally* 49 U.S.C. § 30111 (2012) (requiring the Secretary of Transportation to "prescribe motor vehicle safety standards"); NHTSA PRELIMINARY STATEMENT, *supra* note 33, at 2 ("NHTSA is responsible for developing, setting, and enforcing Federal motor vehicle safety standards (FMVSSs) and regulations for motor vehicles and motor vehicle equipment.").

100. As noted above, Google is taking advantage of the Low Speed Vehicle Motor Vehicle safety standard in building its first autonomous car. John Markoff, *Google's Next Phase in Driverless Cars: No Steering Wheel or Brake Pedals*, N.Y. TIMES (May 27, 2014), http://www.nytimes.com/2014/05/28/technology/googles-next-phase-in-driverless-cars-no-brakes-or-steering-wheel.html ("The low speed will probably keep the cars out of more restrictive regulatory categories for vehicles, giving [Google] more design flexibility."). *See generally* NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP'T OF TRANSP., *supra* note 13 (outlining requirements for low speed vehicles).

the reason first generation autonomous cars will look pretty much like other cars available at the time first generation autonomous cars emerge.

So far, NHTSA has not promulgated regulations or safety standards that specifically address autonomous vehicles. As noted earlier, NHTSA has announced its intention to require Connected Vehicle V2V technologies as FMVSS standard equipment on all passenger cars.[101] However, this V2V requirement would not single out autonomous cars. In NHTSA's 2013 *Preliminary Statement of Policy Concerning Automated Vehicles*, the agency concluded:

> We believe there are a number of technological issues as well as human performance issues that must be addressed before self-driving vehicles can be made widely available. Self-driving vehicle technology is not yet at the stage of sophistication or demonstrated safety capability that it should be authorized for use by members of the public for general driving purposes.[102]

The agency also noted that, as of 2013, "NHTSA does not recommend that states authorize the operation of self-driving vehicles for purposes other than testing at this time."[103]

By 2015, four states and the District of Columbia had enacted legislation authorizing testing of autonomous vehicles.[104] Nevada law permits both testing and operation of autonomous vehicles on Nevada roads.[105] In California, 2012 legislation directed the state's Department of Motor Vehicles (DMV) to adopt regulations for both testing and operation of autonomous vehicles in California.[106] The DMV adopted regulations that permit testing of autonomous vehicles in

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101. *See* Federal Motor Vehicle Safety Standards: Vehicle-to-Vehicle (V2V) Communications, 79 Fed. Reg. at 49,270, 49,272.

102. NHTSA PRELIMINARY STATEMENT, *supra* note 33, at 14.

103. *Id.*

104. AM. ASS'N OF MOTOR VEHICLE ADM'RS, AUTONOMOUS VEHICLE INFORMATION SHARING GROUP ANALYSIS OF LAWS ENACTED IN JURISDICTIONS (2014), *available at* http://www.aamva.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=5826&libID=5802.

105. NEV. REV. STAT. § 482A.100 (2013); NEV. ADMIN. CODE §§ 482A.200–.290 (2014).

106. CAL. VEH. CODE § 38750 (West 2013). Insight into California's regulatory process regarding autonomous vehicles is provided in Bernard C. Soriano et al., *Autonomous Vehicles: A Perspective from the California Department of Motor Vehicles*, *in* ROAD VEHICLE AUTOMATION 15, 15–24 (Geron Meyer & Sven Beiker, eds. 2014).

California,[107] but was unable to meet a January 1, 2015 statutory deadline for regulations permitting regular public operation of autonomous vehicles on California roads.[108] Because of difficulties in determining just how safe first generation autonomous cars should be required to be in California, autonomous vehicles are not yet allowed to be driven by the general public on California roads.[109] State legislation authorizing operation of autonomous vehicles remains pending in a number of states, but such legislation has in the past failed to pass in a far greater number of states than the number of states that have enacted autonomous vehicle authorizing legislation.[110]

So far, municipal ordinances have not yet focused on autonomous cars for special local regulation.[111] In the meantime, existing local ordinances regarding parking, speed limits, yielding to pedestrians, and bicycles will apply to first generation autonomous cars.[112] Experience with regulation of

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107. CAL. CODE REGS. tit. 13, §§ 227.00–.52 (2015).

108. CAL. DEP'T OF MOTOR VEHICLES, INVITATION TO PRE-NOTICE PUBLIC DISCUSSIONS ON PROPOSED REGULATIONS: AUTONOMOUS VEHICLES 1 (2014), *available at* https://www.dmv.ca.gov/portal/wcm/connect/16b7c922-258b-41cf-aee0-431b10091ba9/012715_workshop_public_notice.pdf?MOD=AJPERES; *see also* CAL. VEH. CODE § 38750(d)(1) (setting a January 1, 2015 deadline for regulations). According to the DMV's notice regarding additional hearings on January 27, 2015, there remain uncertainties regarding "certifications by manufacturers that the autonomous technology can be operated safely on public streets by the general public, and how the department will determine the validity of those certifications." CAL. DEP'T OF MOTOR VEHICLES, *supra*.

109. CAL. VEH. CODE § 38750 (permitting use for testing only); CAL. CODE REGS. tit. 13, §§ 227.04, 227.34, 227.48 (outlining requirements for testing by manufacturers only); CAL. DEP'T OF MOTOR VEHICLES, *supra* note 108, at 1 (calling for a public discussion "to facilitate the development of proposed regulations related to the safe operation of Autonomous Vehicles").

110. *See* Gabriel Weiner & Bryant Walker Smith, *Automated Driving: Legislative and Regulatory Action*, CTR. FOR INTERNET & SOC'Y, http://cyberlaw.stanford.edu/wiki/index.php/Automated_Driving:_Legislative_and_Regulatory_Action#State_Bills. Some, but not all, of the legislation referenced at this site is related to autonomous vehicles.

111. However, the state of Tennessee found it necessary to enact a statute that restricts localities from excluding autonomous vehicles from their local boundaries. Act of May 6, 2015, 2015 Tenn. Pub. Acts ch. 307 (2015), *available at* https://trackbill.com/s3/bills/TN/109/HB/616/texts/enrolled.pdf ("No political subdivision may by ordinance, resolution, or any other means prohibit within the jurisdictional boundaries of the political subdivision the use of a motor vehicle equipped with autonomous technology if the motor vehicle otherwise complies with all safety regulations of the political subdivision.").

112. *See infra* Part V.A.2.

electric vehicles at the local level suggests that once state laws license first generation autonomous cars to operate on public roads, local municipal regulation will probably follow.[113]

2. State Roadway Laws and Regulations

First generation autonomous cars will almost certainly have to comply with then-applicable state roadway laws and regulations for a couple of reasons, in addition to the absence of federal preemption. First, each state owns and controls the highways and roadways within that state, including interstate highways.[114] That makes the states' interests in the regulation of the use of state property particularly strong. Second, first generation autonomous cars would only be a very small proportion of the users of state roads.[115] All of the rest of the roadway users—conventional cars, trucks, buses, motorcycles, etc.—would continue to abide by existing roadway rules. To suddenly have a different set of roadway laws and regulations just for autonomous cars, but applicable to no other vehicles, could result in confusion and the kind of unpredictability that leads to vehicle crashes. As a result, most state roadway laws and regulations can be expected to apply to first generation autonomous vehicles, just as they apply to other road users. For example, first generation of autonomous cars will likely have to obey existing traffic laws, speed limits, stop signs, roadway maintenance directions, road closures, and the like,

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113. *See, e.g.*, WASH. STATE DEP'T OF COMMERCE, ELECTRIC VEHICLE INFRASTRUCTURE: A GUIDE FOR LOCAL GOVERNMENTS IN WASHINGTON STATE 3, 5 (2010), *available at* http://www.psrc.org/assets/4325/EVI_full_report.pdf (providing model regulation for local municipalities to comply with electric car legislation at the state level); NCPEV TASKFORCE, PARKING ENFORCEMENT FOR PLUG-IN ELECTRIC VEHICLE CHARGING STATIONS (2014), *available at* http://www.advancedenergy.org/portal/ncpev/resources/PEV_Planning_Toolbox_ParkingEnforcement.pdf (describing municipal parking regulations for electric cars in various states, guided by state laws).

114. *See* Am. Road & Transp. Builders Ass'n, *Transportation FAQs*, ARTBA, http://www.artba.org/about/transportation-faqs/#1 (last visited Mar. 6, 2015) ("Almost all roads, bridges, airports and transit systems in the U.S. are owned by state and local governments or government-created agencies . . . ."); *Interstate FAQ*, FED. HIGHWAY ADMIN., U.S. DEP'T OF TRANSP., http://www.fhwa.dot.gov/interstate/faq.htm#question5 (last visited Apr. 2, 2015) ("The States own and operate the Interstate highways.").

115. See *supra* note 7 for estimates on market penetration of autonomous vehicles.

just as these laws and regulations apply to conventional vehicles.

Later, as autonomous cars become more prevalent and their safety capacities are demonstrated, continued application of some state regulations to autonomous cars may seem to make little sense.[116] However, state laws and regulations necessary for conventional vehicles will continue to apply as long as there are conventional vehicles on the roadways. Ultimately, vehicle regulations that apply specifically to autonomous cars are likely to evolve. How such autonomous vehicle regulatory evolution may occur—as well as the potential for state laws that may phase out road use by conventional vehicles—will pose intriguing legal issues for later generations of autonomous cars.

Adopted under state authority, local laws and ordinances typically regulate vehicle usage, particularly with regard to local roadway safety, pedestrian safety, and parking.[117] Initially, these existing local ordinances will also apply to autonomous cars.[118] Normally protective of pedestrians and bicycles against any form of motorized vehicle, local ordinances will almost certainly include protections for these vulnerable road-users against autonomous cars. The most interesting local-law adaptations to autonomous cars will likely be with regard to parking. Because autonomous cars will be capable of more precise and compressed parking, parking facilities for these cars can be more compact and dense, and can be located

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116. For example, bans on texting or consuming alcohol while driving may become obsolete when a vehicle operates without input from a human driver. *See* Sophia H. Duffy & Jamie Patrick Hopkins, *Sit, Stay, Drive: The Future of Autonomous Car Liability*, 16 SMU SCI. & TECH. L. REV. 453, 478 (2013).

117. *See* Smith, *supra* note 26, at 416 (discussing various types of laws that bear on the legality of automated vehicles, including "statutes of [states] and other jurisdictions; regulations and practices of administrative agencies within these jurisdictions; and ordinances and other enactments of municipalities and other local authorities"); *see, e.g.*, MICH. COMP. LAWS § 257.606 (2009) (reserving for local authorities the power to regulate parking and operation of vehicles); FED. HIGHWAY ADMIN., U.S. DEP'T OF TRANSP., A RESIDENT'S GUIDE FOR CREATING SAFER COMMUNITIES FOR WALKING AND BIKING 11 (2015), *available at* http://safety.fhwa.dot.gov/ped_bike/ped_cmnity/ped_walkguide/residents_guide2014_final.pdf ("Local transportation agencies . . . [are] usually responsible for maintaining and operating local public streets and trails and developing plans for improvements.").

118. *See supra* text accompanying notes 112–13.

in remote facilities away from congested urban areas.[119] Moreover, scenarios for use of autonomous vehicles in fleets providing personal-mobility-as-a-service would reduce requirements for on-street parking in commercial areas. Distinctive autonomous car parking patterns (potentially relegated to remote facilities) should eventually bring substantial changes in local parking regulations. In the more distant future, there may be no need for on-site garage space for residential buildings, because an autonomous car can be summoned when needed from off-site parking facilities.

3. Potential for Federal Preemption of State Laws

Congress could enact national legislation that regulates autonomous vehicles on a uniform national basis, to the exclusion of state and local laws. Section V.F, *infra*, considers what such a federal statute, hypothetically called the National Autonomous Vehicle Act, might contain. Under the Supremacy Clause of the United States Constitution, such federal autonomous vehicle legislation could preempt varied state laws that will otherwise apply to first generation autonomous cars.[120] If a diversity of state laws regulating autonomous vehicles in different ways appears to stifle the development of autonomous cars, such national law might come under consideration. However, near term prospects for comprehensive national autonomous vehicle legislation are extremely unlikely.[121] Nevertheless, it would be possible for federal law, either by statute or by regulation, to preempt state laws that would otherwise apply to first generation autonomous cars.

Current preemption law, particularly with regard to road transportation matters, is by no means absolutely certain. Over the past fifteen years, the United States Supreme Court has unevenly decided preemption issues in the context of vehicle regulation. Two United States Supreme Court decisions—one

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119. ANDERSON ET AL., *supra* note 82, at 5, 27 ("With the ability to drive and park themselves at some distance from their users, AVs may obviate the need for nearby parking for commercial, residential, or work establishments, which may enable a reshaping of the urban environment and permit new in-fill development as adjacent parking lots are made unnecessary.").

120. *See* U.S. CONST. art. VI, cl. 2.

121. *See* NHTSA PRELIMINARY STATEMENT, *supra* note 33, at 2 (discussing NHTSA's plan to not offer federal guidance on autonomous vehicles in the near future).

regarding air-bags[122] and another regarding seat-belts[123]—appear to indicate that, absent an express statutory provision that explicitly preempts state law, federal law might not sufficiently "occupy the field" of autonomous car standards and requirements to eliminate all state law, particularly state tort law.[124] The two Supreme Court cases wrestled with state laws regarding tort liability, an area of law that has historically been considered especially appropriate for state law.[125] Moreover, standards for use of a state's roadways have also been considered to be particularly appropriate areas for state regulation.[126]

B. CIVIL AND CRIMINAL RESPONSIBILITY

Concerns about civil and criminal liability have already influenced the development of the first generation of autonomous cars. The prospect of significant damages or criminal charges could chill both autonomous vehicle technologies innovation and consumer interest in first generation autonomous cars. A great deal of analysis has already addressed civil liability related to autonomous vehicles.[127] Somewhat less attention has been paid to criminal law and law enforcement issues.[128] First generation

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122. Williamson v. Mazda Motor of Am., Inc., 131 S. Ct. 1131 (2011) (involving seat belts and finding no federal preemption in a unanimous 8–0 decision).

123. Geier v. American Honda Motor Co., 529 U.S. 861 (2000) (involving airbags and finding preemption of state tort law claims under the federal National Traffic and Motor Vehicle Safety Act and FVMSS 208, in a 5–4 decision).

124. *See also* ANDERSON ET AL., *supra* note 82, at 131 ("[R]ecent decisions . . . suggest that the Supreme Court will be cautious in finding state court tort claims preempted absent evidence of express legislative intent.").

125. *Geier*, 529 U.S. at 861–68.

126. *See id.*

127. *See generally* ANDERSON ET AL., *supra* note 82, at 41–54; JOHN VILLASENOR, BROOKINGS INST. CTR. FOR TECH. INNOVATION, PRODUCTS LIABILITY AND DRIVERLESS CARS: ISSUES AND GUIDING PRINCIPLES FOR LEGISLATION (2014), *available at* http://www.brookings.edu/~/media/research/files/papers/2014/04/products-liability-driverless-cars-villasenor/products_liability_and_driverless_cars.pdf. *See also* Dorothy J. Glancy, *Sharing the Road: Smart Transportation Infrastructure*, 41 FORDHAM URB. L.J. 1617, 1644 & n.140 (2013).

128. *See* Frank Douma & Sarah Aue Palodichuk, *Symposium, Criminal Liability Issues Created by Autonomous Vehicles*, 52 SANTA CLARA L. REV. 1157 (2012); *see also* Jeffrey K. Gurney, *Driving Into the Unknown:*

autonomous cars are likely to encounter civil and criminal liability primarily under state laws that vary widely across the United States, although federal laws and regulations will affect legal standards regarding autonomous cars and federal law could be enacted in these areas.

1. Civil Liability

Several types of potential defendants could face civil liability associated with first generation autonomous cars. Most obvious are autonomous car manufacturers, together with autonomous vehicle component manufacturers, car dealers, and others within the autonomous car supply chain.[129] In addition, civil liability is likely to attach to users and owners of autonomous cars.[130] Much less anticipated is the potential civil liability that may attach to what are sometimes called "peripheral defendants," such as state or local government defendants who may be responsible in tort with regard to design and maintenance of roadway infrastructure.

Either tort or warranty theories could be the basis for civil liability of autonomous car manufacturers and their cohorts who sell autonomous cars or their components. Tort law would apply when an autonomous car leads to personal injury or damage to property other than the autonomous car itself.[131] Warranty law would apply when harm associated with an autonomous car involves either the car being less valuable or less fit for use than expected or "economic" losses associated with a defective product.

At present, tort law will subject manufacturers, distributors, and sellers of autonomous cars to products liability based either on negligence, when injuries result from a failure to exercise reasonable care in producing, distributing, or selling a product, or on strict products liability for defective products, regardless of the defendant's fault.[132] A few states do

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Examining the Crossroads of Criminal Law and Autonomous Vehicles, 5 WAKE FOREST J.L. & POL'Y (forthcoming 2015), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2543696.

129. *See* VILLASENOR, *supra* note 127, at 7.

130. Owners of cars are presently sued in tort actions involving cars. *See id.* at 13 ("Autonomous vehicles will complicate the already complicated entanglements between insurance providers, plaintiffs, drivers/owners named as defendants, and manufacturers.").

131. *See id.* at 7.

132. *See id.* at 7–8.

not recognize strict liability and require proof of negligence in products liability suits.[133] Negligence liability generally requires proof that (1) the defendant owed the plaintiff a duty of care; (2) the defendant breached this duty; (3) this breach was a necessary cause of the plaintiff's harm, in the sense that the plaintiff's harm would not have occurred had the defendant acted with reasonable care; (4) the breach of duty was a "proximate" cause of the plaintiff's harm; and (5) the plaintiff suffered a legally cognizable injury as a result of the defendant's breach of its duty of care.[134] In some cases where a product has unaccountably failed, the doctrine of *res ipsa loquitor* is used to raise an inference of negligence.[135]

A vast majority of states would apply strict liability rather than negligence to products liability claims for injuries and damages caused by a defective autonomous car.[136] Following the Restatement (Third) of Torts, most states recognize three different types of product defects: "manufacturing" defects, "design" defects, and "warning" defects.[137] Products liability would typically apply to situations in which a problematic design or warning choice made the autonomous car "not reasonably safe."[138] The application of products liability to autonomous cars is likely to be complicated by the nature of the

133. Five states—Delaware, Massachusetts, Michigan, North Carolina, and Virginia—reject strict liability. *See* Joseph v. Jamesway Corp., 1997 WL 524126, at *2 (Del. Super. Ct. 1997); Commonwealth v. Johnson Insulation, 682 N.E.2d 1323, 1326 (Mass. 1997); Prentis v. Yale Mfg. Co., 365 N.W.2d 176, 187 (Mich. 1984); Bryant v. Adams, 448 S.E.2d 832, 845 (N.C. Ct. App. 1994); Harris v. T.I., Inc., 413 S.E.2d 605, 609–10 (Va. 1992).

134. Negligence liability would be based on an autonomous car manufacturer's failure to exercise reasonable care in designing or building a product that causes reasonably foreseeable harm. *See* RESTATEMENT (THIRD) OF TORTS: LIAB. FOR PHYSICAL & EMOTIONAL HARM §§ 6–7 (2010).

135. *Id.* at § 17.

136. Strict liability can be imposed without fault on the part of the manufacturer if an autonomous car were considered to be an unreasonably dangerous product. Even though a manufacturer or seller of an autonomous car has exercised all possible care, if the car causes harm because it turns out to be unreasonably dangerous, the manufacturer or seller of the autonomous car can be held responsible for harm that results even when the manufacturer or seller is determined to have engaged in no faulty behavior. *See* RESTATEMENT (THIRD) OF TORTS: PROD. LIAB. § 2 (1998); RESTATEMENT (SECOND) OF TORTS § 402A (1965) (listing cases from nearly every state regarding "Special Liability of Seller of Product for Physical Harm to User or Consumer").

137. *See* RESTATEMENT (THIRD) OF TORTS: PROD. LIAB. § 2.

138. *See id.*

product that blends interactive technologies and components from a number of sources into making the car autonomous. Moreover, to the extent that autonomous cars are often remotely connected to manufacturers of vehicles and vehicle components,[139] the warning obligations of autonomous car manufacturers will reach far beyond the point of sale. At the same time, product design-defect claims arising out of autonomous cars are likely to encounter novel challenges in seeking to establish that a particular algorithm or program installed within the vehicle was not reasonably safe.

Warranty liability based on contract law will provide an additional basis for autonomous car manufacturer and seller liability for defects that result in loss to purchasers. Both express and implied warranties can provide a basis for civil liability.[140] In particular, the Uniform Commercial Code's (UCC) implied warranty of merchantability is likely to provide a basis for civil liability claims against sellers and manufacturers of autonomous cars.[141] By placing an autonomous car into the market, a manufacturer or seller impliedly certifies that the car is reasonably capable of its intended use as an autonomous car.

In addition, manufacturers or sellers of autonomous cars can be sued for unfair trade practices alleging fraud or misrepresentation in the sale of defective products. In many cases of defective products and improper marketing and sales tactics, liability is based on consumer protection statutes.[142] Trends toward liability based on statutory consumer protection remedies are likely to include consumer protection liabilities associated with autonomous cars.[143]

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139. First generation autonomous cars are likely to require frequent programing updates as well as updated mapping. *See* ANDERSON ET AL., *supra* note 82, at 75–76.

140. In most cases, these warranties would take the form of assurances that an autonomous car is of sufficient quality for its intended use. *See* U.C.C. § 2-314 (2012). *Cf.* VILLASENOR, *supra* note 127, at 12. In addition, as noted above, federal and state Lemon Laws usually are based on product warranties. Glancy, *supra* note 127, at 1643 & n.129.

141. *See* U.C.C. § 2-314; VILLASENOR, *supra* note 127, at 12.

142. Glancy, *supra* note 127, at 1643.

143. *See, e.g.*, Magnuson–Moss Warranty Act, 15 U.S.C. §§ 2301–2312 (2012). In addition, many states have what are called "lemon law" programs that require repair or replacement of defective products. These programs already apply to motor vehicles and would logically extend to first generation autonomous cars. For information about the Lemon Law statutes of various

A second category of potential liability defendants likely to be associated with first-generation autonomous cars are the owners and users of these first autonomous cars. Negligence law will provide a basis for imposing civil liability on the owner or user of an autonomous car for injuries associated with its use.[144] In addition to common law negligence, statutory negligence—or "negligence per se"—based on a statute or ordinance often relies on a standard of reasonable care provided in a statute or ordinance.[145] It is not completely clear that all of these liability rules will be applied to autonomous cars once there are statutes or regulations that specifically govern the use of autonomous vehicles. Because an autonomous car user is not a "driver," traditional allocations of responsibilities to avoid accidents among vehicle drivers, passengers, owners, and manufacturers will raise some novel legal issues. Moreover, if the first generation of autonomous cars is limited to corporate fleets used by employees on the corporations' campuses, injuries to corporate employees caused by these autonomous cars may fall under workers' compensation schemes.

A third category of potential defendants in civil lawsuits arising out of first generation autonomous cars are "peripheral" defendants, such as local governments that fail to repair unsafe roads. In states where government liability presumes that a government's obligations are "ministerial," as opposed to "discretionary," such activities as infrastructure maintenance by government agencies would not be protected by liability from sovereign immunity.[146] The initial design of roads—as

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states, see *Publications*, INT'L ASS'N OF LEMON L. ADMINS., http://www.ialla.net/pub_1.htm (last updated Jan. 28, 2015).

144. ANDERSON ET AL., *supra* note 82, at 112 (discussing negligence theory regarding driver and owner liability).

145. For example, a number of states have statutes regarding "driverless" (i.e., run away) vehicles. *E.g.*, CAL. VEH. CODE § 16001 (West 2012) ("If the vehicle involved was a driverless runaway vehicle and was parked with the express or implied permission of the registered owner, the registered owner of the vehicle shall be construed to have been the driver of the vehicle for the purposes of this chapter.").

146. *See, e.g.*, R. Perry Sentell, Jr., *"Official Immunity" in Local Government Law: A Quantifiable Confrontation*, 22 GA. ST. U. L. REV. 597, 620–26 (2006) (discussing various ministerial and discretionary duties as they relate to upkeep of Georgia roads); Stuart P. Green, *The Criminal Prosecution of Municipal Governments*, 72 N.C. L. REV. 1197, 1211 (1994) (discussing cases

well as of potential vehicle communications systems—to accommodate first generation autonomous cars will probably require exercise of significant discretion by the responsible government agencies. However, once the roadway and communications infrastructure is established, its upkeep may provide a "ministerial" duty basis for civil liability, unprotected by sovereign immunity, on the part of state and local government entities.[147]

In considering civil liability, it is also worthwhile to note that litigation practices in cases involving first generation autonomous cars will likely be somewhat different from litigation practices in other areas of civil liability. Given the crash-avoidance safety technologies to be built into autonomous cars, there may not be very much civil litigation involving autonomous cars. However, because of the advanced technologies incorporated in autonomous cars, the nature of the evidence (such as algorithms and sensor data) and of experts (such as automated systems and robotics engineers) are likely to make such litigation especially challenging and complex technologically.

2. Criminal Law and Procedure

When first generation autonomous cars begin to operate on public roads, a number of existing criminal offenses will naturally apply to these autonomous cars.[148] In other contexts, however, first generation autonomous cars will challenge traditional criminal law concepts and applications. To the extent that first generation autonomous vehicles are programmed to comply with all traffic laws, citations of autonomous vehicles for traffic law infractions will be

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that wrestle with the ministerial versus discretionary distinction for infrastructure maintenance in New Jersey).

147. The law varies from state to state because each state tends to deal with sovereign immunity and comparative liability in its own way. In most states, government liability presumes the existence of a "ministerial" duty as opposed to a "discretionary" obligation by the government with regard to roadway infrastructure. *See, e.g.*, Michael R. Flaherty, *Cause of Action Against Governmental Entity for Physical Injury or Property Damage Caused By Defective Design or Condition of Street or Highway*, *in* 10 CAUSES OF ACTION 2d 397, § 2 (1998); *see also* Roland Nikles, *"Is It Public, or Is It Not?" What To Watch for When Public and Private Become Entwined, and Why It Matters,* 46 PROCUREMENT LAW., no. 3, 2011, at 5, 8.

148. For example, a vehicle being parked blocking a driveway or in a fire lane. *See, e.g.*, CAL. VEH. CODE §§ 22500–22526 (West 2014).

vanishingly rare.[149] Of course, if an operator or owner of an autonomous car has deliberately programed the autonomous vehicle to disregard traffic laws, the operator-programmer would likely be liable for traffic infractions that result.[150]

Overall, widespread use of autonomous vehicles, presumably programmed to comply with traffic laws and rules of the road, should eventually lead to crime-reduction in terms of fewer traffic law infractions.[151] To the extent that first generation autonomous cars incorporate technologies that prevent vehicle theft and vehicle tampering offenses, incidence of those offenses will be reduced.[152] Use of first generation autonomous vehicles would also plausibly reduce the incidence of some impaired driving crimes, such as driving under the influence.[153] On the other hand, some traffic offenses such as speeding or tailgating are designed to prevent harm by deterring driving behavior associated with potential vehicle crashes. Since first generation autonomous cars are expected to have crash-avoidance built in so as to minimize risks of harm from car crashes, some criminal laws based on deterrence of harm-producing behavior may no longer be logically based. At the very least, the advent of first generation autonomous cars should suggest reconsideration of criminal laws associated with vehicle use so that the distinctive risk profiles of autonomous vehicles are better reflected in criminal laws and law enforcement.

In some cases, autonomous cars may create difficult issues of criminal law policy, such as whether and when criminal penalties should apply to programming decisions that produce

149. Douma & Palodichuk, *supra* note 128, at 1160 & n.8.

150. *Cf. id.* ("If a car were truly in passenger mode any violation would be a malfunction on the part of the vehicle.").

151. *Id.* ("[L]aws to address common issues, such as speeding and stopping for stop signs, are fairly simple: program autonomous vehicles to comply with all statutes and regulations regarding the rules of the road.").

152. *Id.* at 1160 n.9.

153. *Alcohol-Impaired Driving*, INS. INST. FOR HIGHWAY SAFETY & HIGHWAY LOSS DATA INST. (May 2015), http://www.iihs.org/iihs/topics/laws/dui?topicName=alcohol-impaired-driving ("All 50 states and the District of Columbia have per se laws making it a crime to drive with a blood alcohol concentration (BAC) at or above a specified level, currently 0.08 percent (0.08 g alcohol per 100 ml blood).").

avoidable crashes or other socially undesirable consequences.[154] At a minimum, it seems likely that first generation autonomous cars will stimulate changes in the existing model of local traffic law regulation that relies upon low-level criminal sanctions for deterrence of a wide spectrum of anti-social behavior. However, autonomous vehicles are likely to generate fewer traffic stops because first generation autonomous cars are expected to be programmed to obey all traffic laws and signs.[155] This reduction in the number of stops for traffic violations could have a profound effect on police staffing, deployment, and practices. At present just over half of all citizen contacts with police occur in connection with traffic stops.[156] For example, "pretext" traffic stops, in which officers use a perceived traffic law violation (such as failure to signal a turn) as a basis for investigating a different crime, may become more rare as first generation autonomous cars become a larger presence on roads and highways.

The first generation of autonomous cars may also lead to the legislative creation of new crimes. For example, legislative enactments may proscribe certain times, places, and manners of autonomous car usage and nonusage.[157] For the most part, such autonomous-car-use offenses would likely entail very limited *mens rea* requirements, carry low penalties, and would be enforced primarily by local governments.

The federal government could enact regulatory offenses related to autonomous cars. For example, federal crimes might penalize the manufacture of autonomous vehicles designed to produce dangerous consequences or the collection and use of personal information generated by autonomous vehicles in interstate commerce. Federal crimes could also specifically prohibit malicious interference with the operation of highway

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154. *See* Duffy & Hopkins, *supra* note 116; F. Patrick Hubbard, *"Sophisticated Robots": Balancing Liability, Regulation, and Innovation*, 66 FLA. L. REV. 1803, 1840 (2014).

155. Douma & Palodichuk, *supra* note 128, at 1160.

156. CHRISTINE EITH & MATTHEW R. DUROSE, BUREAU OF JUSTICE STATISTICS, DEP'T OF JUSTICE, CONTACTS BETWEEN POLICE AND THE PUBLIC, 2008 2 (2011), *available at* http://www.bjs.gov/content/pub/pdf/cpp08.pdf.

157. For example, local laws could ban autonomous vehicles from certain parts of town or, on the other hand, provide that only autonomous cars would be permitted in certain areas. *Cf. Congestion Charge*, TRANSPORT FOR LONDON, http://www.tfl.gov.uk/modes/driving/congestion-charge (last visited Apr. 10, 2015).

and communications infrastructure upon which first generation autonomous cars are likely to depend. With regard to such possible federal criminal statutes, the Congress would face difficult choices about whether to rely upon criminal sanctions or to use alternative enforcement mechanisms such as civil and regulatory remedies. Moreover, if the federal government were to establish a broad spectrum of autonomous vehicle crimes, one consequence would be the increased federalization of a sphere (traffic law) that historically has been the province of state and local governments.[158]

Misuse of autonomous cars in the commission of crimes is yet another area in which new types of crimes may emerge. For example, new criminal statutes may specifically criminalize the use of autonomous cars to commit another existing crime, such as theft or proscribed acts of violence.[159] The misconduct may already be potentially prohibited under the generic language of a broader criminal statute, such as criminal mayhem.[160] But the use of an autonomous car in such criminal activities may be cause for special concern, and special prohibition.

A different type of extension of existing criminal law principles may prohibit tampering with autonomous cars and their supporting infrastructure by their users (e.g., overriding safety devices)[161] or by outsiders (e.g., collecting information transmitted by autonomous vehicles).[162] Once first generation autonomous cars are on the road, unanticipated criminal behavior may gradually appear. For example, the potential vulnerability of autonomous cars' automated controls to hackers suggests serious risk of criminal mischief.[163] Indeed,

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158. *See supra* text accompanying notes 122–26.

159. These criminal statutes would be similar to existing firearm use sentencing enhancements. *See*, *e.g.*, CAL. PENAL CODE §§ 12021.5–12022.55 (West 2014) (enhancing sentences for felonies committed while carrying a firearm).

160. *E.g.*, CAL. PENAL CODE §§ 203–205 (West 2014).

161. Vehicle tampering is already a crime in many states. *E.g.*, MINN. STAT. § 609.546 (2014). It is also a federal crime to tamper with vehicle odometers. 49 U.S.C. § 32703 (2012). The federal odometer statute provides criminal penalties for odometer tampering. *Id.* § 32709(b).

162. For example, federal law provides criminal penalties under the Electronic Communications Privacy Act, 18 U.S.C. § 2510–2511 (2012), and under the Computer Fraud and Abuse Act, *id.* § 1030.

163. *Id.* at 158 (citing an example where a hacker was already able to "access a car's electronic systems through a seemingly innocuous tire pressure gauge," suggesting capacity for further damage).

the FBI has already cautioned that autonomous cars may be used to facilitate acts of terrorism.[164]

Law enforcement interaction with first generation autonomous cars may also generate some novel Fourth Amendment search and seizure issues. For example, no court has decided whether a warrant would be required before a law enforcement agency could send a signal to an autonomous vehicle's automated systems to bring the vehicle to a safe stop at a given location. However, the United States Supreme Court recognized in *United States v. Jones* that a Fourth Amendment "search" occurred when the government attached a GPS device to a vehicle and then used the device to track the movements of a suspect's vehicle over the course of a month.[165] In her concurring opinion, Justice Sotomayor noted that it remains unclear whether a similar search rule would apply if the GPS device had already been in the vehicle,[166] as will be the case with most, if not all, first generation autonomous vehicles. Subsequently, in *Riley v. California* the United States Supreme Court required a warrant before law enforcement officers could lawfully search the internal files of a smart phone.[167] The advent of the first generation of autonomous cars will pose the further question whether an autonomous vehicle's systems are at least as worthy of protection against warrantless law enforcement searches as those of a smart phone.

C. INSURANCE

Insurance law will present a puzzling situation for first generation autonomous cars. First generation autonomous cars will contend with at least fifty different forms of state motor vehicle insurance laws. Because the federal government ceded by statute most automobile insurance regulation to the states in 1945, insurance laws and regulations that will affect first generation autonomous cars will be mostly in the form of state

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164. Mark Harris, *FBI Warns Driverless Cars Could Be Used as 'Lethal Weapons'*, GUARDIAN (July 16, 2014), http://www.theguardian.com/technology/2014/jul/16/google-fbi-driverless-cars-leathal-weapons-autonomous.

165. United States v. Jones, 132 S. Ct. 945 (2012).

166. *Id.* at 955 (Sotomayor, J., concurring) ("With increasing regularity, the Government will be capable of duplicating the monitoring undertaken in this case by enlisting factory- or owner-installed vehicle tracking devices or GPS-enabled smartphones.").

167. Riley v. California, 134 S. Ct. 2473 (2014).

law.[168] To the extent that first generation autonomous cars would be used for livery purposes, such as taxis, limousines, and on-demand ride services, they may be regulated by state public utilities commissions, which require minimum levels of commercial insurance.[169]

The federal government has authority to regulate car insurance as an aspect of interstate commerce.[170] Currently, federal law requires minimum insurance levels for commercial vehicles that travel interstate.[171] Although autonomous commercial vehicles traveling in interstate commerce would be subject to minimum insurance levels set by the federal government,[172] first generation autonomous passenger cars will be subject only to state laws regarding automobile insurance laws absent a statutory change. Although, as discussed below, federal statutes such as the hypothetical National Autonomous Vehicle Act could establish a unified national insurance system for autonomous cars or, more broadly, for autonomous vehicles in general,[173] such a federal insurance system seems unlikely in light of longstanding automobile insurance regulation under state law.

All states except New Hampshire have adopted some form of mandatory automobile insurance.[174] However, various states have different models for regulating automobile insurance, policy terms, cost-rating factors, liability limits, and uninsured

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168. McCarran-Ferguson Act, 15 U.S.C. §§ 1011–1015 (2012).

169. For example, in California, ridesharing companies such as Uber, Lyft, and Sidecar are regulated as Transportation Network Companies and are subject to special insurance requirements. CAL. PUB. UTIL. CODE § 5391 (West 2014); CAL. PUB. UTILITIES COMM'N, OVERVIEW OF LIMOUSINE AND TRANSPORTATION NETWORK COMPANY REGULATIONS (2014), *available at* http://www.cpuc.ca.gov/NR/rdonlyres/208D6DD5-F4A3-4A66-8B7C-65CDB0F4265E/0/TNCLimoRegulation_v1.pdf.

170. A 1944 United States Supreme Court decision confirmed that the federal government has authority to regulate motor vehicle insurance. United States v. South-Eastern Underwriters Ass'n, 322 U.S. 533 (1944). Later, this decision was superseded by the McCarran-Ferguson Act in 1945. 15 U.S.C. §§ 1011–1015. However, the principle of federal authority over motor vehicle insurance remains unchanged.

171. 49 U.S.C. § 13906 (2012); 49 C.F.R. § 387.1 (2013); *Insurance Requirements*, FMSCA, U.S. DEP'T TRANSP., http://www.fmcsa.dot.gov/registration/insurance-requirements (last updated Apr. 27, 2015).

172. 49 U.S.C. § 13906; 49 C.F.R. § 387.1.

173. See discussion of NAVA, *infra* Part V.F.

174. *Compulsory Auto/Uninsured Motorists*, INS. INFO. INST. (May 2015), http://www.iii.org/issue-update/compulsory-auto-uninsured-motorists.

or underinsured motorist coverage.[175] Although automobile insurance is generally advertised as being designed to protect the assets of the driver, automobile insurance also serves broader social policy by insuring that an injured party has access to funds (up to the policy limits) on which a person injured by a motor vehicle can claim for compensation.[176] Insurance for first generation autonomous cars would be no different, absent a national autonomous car insurance program being mandated by federal statute.

The fault of "drivers" is what triggers coverage by insurance policies under existing automobile insurance laws of most states.[177] First generation autonomous vehicles would have to somehow be made to fit within these driver-focused state systems that depend on establishing driver fault. Otherwise they would have to be treated as a completely separate category for insurance purposes. Since NHTSA estimates that at least ninety-three percent of car crashes are caused by human error,[178] first generation autonomous cars (which by definition will not have human drivers) would seem to be an excellent insurance risk.

Nevertheless, autonomous cars that drive themselves will present challenges under the present insurance models. It is uncertain how, if at all, injured parties could be compensated under most insurance policies if a driver is not found to be at fault. Moreover, in states where automobile insurance is mandatory for drivers (but not for motor vehicles), it is unclear whether autonomous cars (which have no drivers) will be required to purchase insurance, or, if insurance is required, what that insurance should cost or cover.

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175. *Id.*

176. *Id.* (stating that compulsory insurance laws "require[] that drivers be able to demonstrate that they are able to provide sufficient funds in the event of an 'at-fault' accident").

177. *Id.* Even no-fault automobile insurance insures drivers (and those associated with them) rather than the vehicles. No-fault automobile insurance is required in twelve states and Puerto Rico; other states provide for no-fault insurance as an option. *No-Fault Auto Insurance*, INS. INFO. INST. (Feb. 2014), http://www.iii.org/issue-update/no-fault-auto-insurance.

178. NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP'T OF TRANSP., SAMPLING DESIGN USED IN THE NATIONAL MOTOR VEHICLE CRASH CAUSATION SURVEY 17 (2008), *available at* http://www-nrd.nhtsa.dot.gov/Pubs/8109 30.PDF.

In short, automobile insurance laws will need to evolve to accommodate autonomous cars that will require a different type of insurance that does not depend on a human driver. As insurance matters now stand, the liability provisions of standard automobile policies insure against liability due to the fault of human drivers.[179] In addition, uninsured and underinsured coverage may insure various people (e.g., an insured driver and relatives living in the insured's home) for damages caused by the fault of an uninsured or underinsured human driver.[180] None of these standard insurance models take account of autonomous cars without human drivers.

The insurance situation facing first generation autonomous cars in California is particularly dire. California is the largest insurance market in the United States and the fourth largest insurance market in the world.[181] As in a number of other states, California law requires that automobile insurance rates be approved in advance by the elected Commissioner of Insurance.[182] However, rate approvals are subject to California's existing driver-based rating system that was adopted by the electorate as a statewide initiative, Proposition 103, in 1988.[183] Proposition 103 imposes specific mandatory requirements that the most important rating factors must be, in descending order: the driver's driving record, the number of miles the driver drives annually, and the driver's number of years of driving experience.[184] Given the absence of these three factors in the case of an autonomous car, it is unclear what risk factors can be considered when setting the cost of mandatory automobile insurance for an autonomous car. The proposition also requires a twenty percent discount for drivers with good driving records.[185] All of these required factors are driver-centric rather than vehicle-centric. It might be possible to consider the number of miles an autonomous car drives

179. *Id.*

180. *Id.*

181. *Department of Insurance,* ALLGOV CAL., http://www.allgov.com/usa/ca/departments/elected-independents/department_of_insurance?agencyid=191 (last visited Mar. 8, 2015).

182. Robert W. Peterson, *New Technology—Old Law: Autonomous Vehicles and California's Insurance Framework*, 52 SANTA CLARA L. REV. 101, 127 (2012).

183. *Department of Insurance*, *supra* note 181.

184. CAL. INS. CODE § 1861.02(a) (West 2008).

185. CAL. INS. CODE § 1861.02(b).

annually, but those are car-miles, not driver-miles. Moreover, apart from a vote by the entire electorate, propositions such as 103 are extremely difficult to change in California.[186] For now, first generation autonomous cars seem to have no place under California's mandatory automobile insurance system.

In other states that are not as politically restricted with regard to automobile insurance as California, first generation autonomous cars will pose challenges with regard to automobile insurance costs, called insurance rates. Insurers use actuarial data to create "base rates" and "class plans," for various categories of insurance.[187] Insurance actuaries apply existing data about past experience with losses to project losses into the future.[188] In states where insurance regulators approve rates, state insurance regulators make similar calculations. For the very first autonomous cars there will be no past experience with losses. After that, because the artificial intelligence controlling an autonomous car is self-learning, its performance will constantly—and probably fairly rapidly—improve over time. The predictive value of data regarding losses from past autonomous car crashes will not be predictive of future crashes because any past crashes will generate immediate corrective actions in vehicles guided by self-learning artificial intelligence. The resulting lack of predictability based on past loss data is likely to present unique challenges for actuaries under current insurance models.

Insurance companies appreciate the challenge of insuring autonomous cars without human drivers and are working toward solutions.[189] One solution is for a state to calculate insurance costs based on assuming that liability for injuries and damages will be placed on owners or operators of autonomous cars and require autonomous car owners or operators to purchase automobile insurance. Under such an owner-operator insurance model, insurers of autonomous cars would likely seek to pass losses up the retail chain to dealers, manufacturers, and commercial suppliers of autonomous cars

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186. Peterson, *supra* note 182, at 110. Amendment of such state propositions generally requires a vote of the entire state's electorate. *Id.*

187. GEOFF WERNER & CLAUDINE MODLIN, CASUALTY ACTUARIAL SOC'Y, BASIC RATEMAKING 14–15, 150 (4th ed. 2010), *available at* http://www.casact.org/library/studynotes/werner_modlin_ratemaking.pdf.

188. *Id.* at 6.

189. *Self-Driving Cars and Insurance*, *supra* note 27.

and autonomous car components. If, under products liability law, autonomous vehicle sellers and suppliers are held directly responsible, then autonomous vehicle insurance against injuries and property damage will shift from being "personal" insurance to being a form of commercial risk insurance. Such a shift would raise a number of issues, such as whether commercial risk autonomous car insurance should be mandatory, whether there are risks that an autonomous car manufacturer may become insolvent, and whether alternatives to insurance, such as no-fault, self-insurance, or bonding might be preferable.

The existing driver-centric car insurance system appears to be inappropriate in the context of autonomous cars. Other ways to assure compensation for losses associated with autonomous cars may be better, including other types of insurance or financial responsibility measures. Moreover, as noted earlier, autonomous vehicles will be part of a more complex personal mobility infrastructure that is likely to involve interactive technologies such as V2V and V2I.[190] These complex interactive infrastructure features in which first generation autonomous vehicles are likely to participate may in the last analysis render determinations such as fault or causation so exceedingly complex technologically that fault and cause concepts are for all practical purposes illusory. Transaction costs of determining cause and fault may suggest spreading autonomous car insurance burdens for injuries and losses associated with autonomous vehicles more broadly among vehicle users, or across the nation's taxpayers.

D. LAND USE

First generation autonomous cars will have relatively minor immediate impacts on land use, since these cars will be relatively few in number. In the long run, the impact of autonomous cars is much more difficult to estimate. On the one hand, autonomous cars may enhance sustainable communities[191] by fostering patterns of land use that are not only smart, but promote reductions in air pollution, including

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190. *See supra* Part IV.

191. There are dozens of definitions of sustainable communities. *See* PARTNERSHIP FOR SUSTAINABLE COMMUNITIES, http://www.sustainablecommunities.gov/mission/about-us (last updated Mar. 2, 2015).

greenhouse gas emissions, and help encourage more compact mixed-use land development. On the other hand, autonomous cars could be used to encourage scattered residential land development and to increase overall use of personal automobiles.[192]

In the United States, sustainable land use development is often associated with the Partnership for Sustainable Communities, a joint project of the U.S. Department of Housing and Urban Development, U.S. Department of Transportation, and the U.S. Environmental Protection Agency, that "works to coordinate federal housing, transportation, water, and other infrastructure investments to make neighborhoods more prosperous, allow people to live closer to jobs, save households time and money, and reduce pollution."[193] The Partnership's sustainability goals in terms of transportation include "[d]evelop[ing] safe, reliable, and economical transportation choices to decrease household transportation costs, reduce our nation's dependence on foreign oil, improve air quality, reduce greenhouse gas emissions, and promote public health."[194] California's first-of-its-kind Sustainable Communities Act specifically focuses on reduced use of passenger cars and light trucks through measurable decreases in vehicle miles traveled (VMT).[195] Whether use of autonomous cars will reduce VMT is debatable. A 2014 RAND report concluded equivocally that "[t]he potential effects of AVs on aggregate VMT remain unclear, though it seems likely they will lead to more total travel rather than less."[196]

In terms of increasing personal car use, the convenience of autonomous cars for commuting between home and work may

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192. JANE BIERSTEDT ET AL., EFFECTS OF NEXT-GENERATION VEHICLES ON TRAVEL DEMAND AND HIGHWAY CAPACITY 11–18 (2014).

193. PARTNERSHIP FOR SUSTAINABLE COMMUNITIES, *supra* note 191.

194. *Livability Principles*, PARTNERSHIP FOR SUSTAINABLE COMMUNITIES, http://www.sustainablecommunities.gov/mission/livability-principles (last updated Oct. 31, 2013).

195. The VMT concept used in the California statute is an artificial construct based on the assumption that reductions in miles traveled by passenger cars and light trucks will result in directly proportional decreases in greenhouse gas emissions, without accounting for zero emission cars, much less autonomous cars. VMT does not mean total vehicle miles travelled by all vehicles as may be used in calculation of roadway levels of service or in road-use charging systems. *See* Dorothy J. Glancy, *Vehicle Miles Traveled and Sustainable Communities*, 46 MCGEORGE L. REV. 23 (2014).

196. ANDERSON ET AL., *supra* note 82, at 17.

lead to more scattered residential development in rural areas, away from urban centers. The ability to use autonomous car commuting time for other purposes, such as work, rest, or recreation, may make commute time and distance less onerous for autonomous car users. If so, autonomous car users may seek to live in rural or semi-rural areas and thereby contribute to sprawl. Many land planners are concerned that the availability of autonomous cars for more convenient and multi-tasking commuting will result in longer commutes.[197]

1. Urban Concentration

However, autonomous cars could be deployed in ways that lead to reductions in personal car use. For example, autonomous low-speed vehicles will be useful in urban areas, but not as efficient for long highway commutes.[198] It may be that first generation autonomous cars, including ride-service versions, will be an amenity of urban life that encourages residents to choose to live in more compact urban areas. Indeed, efficient use of small, low-speed autonomous cars for providing urban transportation services (online ride-service or taxi applications) requires fairly high population densities. Such autonomous low-speed vehicles work best over relatively short travel distances within an urban area—e.g., from residence to work, recreation, shopping, or public transit hubs for longer distance journeys. If first generation autonomous cars were, by regulation, restricted to use only in urban areas, such a restriction would lead to fewer long-distance miles traveled by first generation autonomous vehicles. In addition, restricting first generation autonomous vehicles to already dense urban areas could make dense urban communities more maneuverable, particularly for elderly and disabled persons for whom personal mobility is often a challenge.[199]

Whether the total number of miles traveled by such urban-restricted first generation autonomous cars would increase or decrease, seems uncertain. A study by the University of Michigan Transportation Research Institute considered the "Potential Impact of Self-Driving Vehicles on Household

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197. *E.g.*, David Levinson, *Climbing Mount Next: The Effects of Autonomous Vehicles on Society*, 16 MINN. J.L. SCI. & TECH. 787 (2015).

198. Such is the announced initial plan for the Google car. *See* O'Brien, *supra* note 9.

199. Loro, *supra* note 18.

Vehicle Demand and Usage."[200] The results of this study show that autonomous cars would likely lead to fewer cars being owned by the average household.[201] At the same time, each vehicle would be driven more intensely (more miles over a given time period) so that roughly the same mileage would be covered by fewer cars.[202] Such a usage pattern would appear to result in cars wearing out sooner, with more frequent new car purchases.[203] If newer autonomous cars have better, cleaner technology, there could be long-term environmental benefits from faster fleet turnover.[204]

Restriction of first generation autonomous cars to urban areas could be accomplished through land and transportation planning regulations that permit the use of autonomous cars only in urban areas, or even designated parts of urban areas. In addition, chronically congested areas within older cities could be zoned for autonomous transport only.[205] In such areas where roadways are narrow and difficult to navigate, the only passenger vehicles allowed to operate might rationally be first generation autonomous cars.

2. Air Pollution Reduction

First generation autonomous cars will probably make small contributions to sustainable community goals of reducing air pollution and greenhouse gas emissions.[206] Although some

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200. BRANDON SCHOETTLE & MICHAEL SIVAK, UNIV. OF MICH. TRANSP. RESEARCH INST., POTENTIAL IMPACT OF SELF-DRIVING VEHICLES ON HOUSEHOLD DEMAND AND USAGE (2015), *available at* http://www.driverlesstransportation.com/wp-content/uploads/2015/02/UMTRI-2015-3.pdf.

201. *Id.* at 12.

202. *Id.*

203. *Id.* at 10.

204. Brad Plumer, *Will Driverless Cars Solve Our Energy Problems—Or Just Create New Ones?*, WASH. POST (Mar. 30, 2013), http://www.washingtonpost.com/blogs/wonkblog/wp/2013/03/30/will-self-driving-cars-solve-all-our-energy-problems-or-create-new-ones/.

205. The London Congestion Charge Zone does something similar by charging vehicles for using roadways within the zone during times of high traffic congestion, with numerous exemptions such as for taxis on hire. *See* THOMAS F. BERALDI, JR., ACCEPTABILITY, IMPLEMENTATION, AND TRANSFERABILITY: AN ANALYSIS OF THE LONDON CONGESTION CHARGE ZONE 3 (2007).

206. Plumer, *supra* note 204; Jonathan Walker & Karen Crofton, *Autonomous Vehicles & Smart Cities Can Cut Auto Fatalities & CO2 Emissions by 2025*, CLEANTECHNICA (Nov. 14, 2014), http://cleantechnica.com

first generation autonomous vehicles could be powered by internal combustion engines, autonomous vehicle regulation could require that first generation autonomous cars be available to consumers only as zero emission vehicles. No matter what their fuel or energy source, first generation autonomous cars are expected to contribute to reductions in air pollution through minimizing road congestion.[207] In addition to reducing traffic congestion, autonomous cars are likely to reduce fuel consumption through intelligent routing and automatic crash-avoidance capacities.[208] Ultimately, autonomous vehicles should be able to reduce vehicle weight for better fuel economy. The capacities of autonomous vehicles' automatic systems to avoid many, if not most, collisions will probably justify reductions in vehicle weight, since robust passive safety measures (e.g., heavy bumpers) may no longer be necessary for occupant safety. [209]

3. Infrastructure

With regard to infrastructure impacts, most transportation experts forecast that the first generation of autonomous cars will have to cope with mixed traffic on existing roadways shared by many kinds of conventional, human-driven vehicles.[210] However, by the time first generation autonomous cars appear on United States roads, two factors may influence the make-up of this mixed traffic. First, over the next few years, conventional vehicles are almost certain to become increasingly automated.[211] Moreover, cooperative vehicle interaction is likely to be pervasive.[212] These factors may ultimately justify designating portions of roadways (dedicated lanes) or entirely segregated roads, with narrower lanes and reduced vehicle intervals, for use only by automated, connected

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/2014/11/14/autonomous-vehicles-smart-cities-can-cut-auto-fatalities-co2-emissions-2025/.

207. Walker & Crofton, *supra* note 206.

208. *Id.*

209. John Capp & Bakhtiar Litkouhi, *The Crash-Proof Car*, IEEE SPECTRUM (Apr. 30, 2014, 2:05 PM), http://spectrum.ieee.org/transportation/safety/the-crashproof-car ("When cars no longer really crash, their frames—designed now to protect occupants during a collision—could be built lighter, making the vehicle more efficient.").

210. GARRISON & LEVINSON, *supra* note 15, at 457.

211. NHTSA PRELIMINARY STATEMENT, *supra* note 33, at 1.

212. NHTSA V2V READINESS, *supra* note 72, at 5, 71.

and autonomous vehicles. Nevertheless, separated dedicated roadway for use only by first generation autonomous vehicles seems unlikely. Requiring additional infrastructure of this type would appear to be too much roadway to be either affordable or tolerable as a use of land, in light of the relatively few first generation autonomous cars.

Of course it would be theoretically possible to designate an existing roadway or highway lane for autonomous car use. For example, an autonomous car lane might be marked as a "star" lane, to distinguish it from existing diamond lanes for carpools, electric vehicles, and tolls. The "star" lane for autonomous cars could be narrower and move faster and would likely have greater throughput than ordinary roadways or travel lanes on highways. Moreover, the availability of such lanes in high-use areas may incentivize acceptance of first generation autonomous cars. Despite all of these benefits, such a proposal would almost certainly generate significant political opposition, as has been the case with carpool lanes and the eligibility of electric vehicles for free use of carpool or High Occupancy Toll (HOT) lanes.[213]

To the extent that first generation autonomous vehicle operation will depend on vehicle communications, additional infrastructure in the form of antennas and roadside processing units will probably be necessary.[214] It is not yet clear whether autonomous vehicles will be equipped with DSRC solely for V2V communications or for V2I communications with roadside infrastructure. V2I would require roadside units or mobile wireless antennas to facilitate these connected vehicle communication modes. Moreover, technologically enhanced beacons or sensor reflectors in or on the roadway infrastructure may be used to assist some autonomous operations.[215] If so, aside from strictly V2V communications, roadside equipment of some sort may need to be added to transportation infrastructure, probably along existing rights of way.[216] Such

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213. Martin Wachs & Brian D. Taylor, RAND Corp., *Make HOT Lanes Permanent*, RAND BLOG (Apr. 23, 2014), http://www.rand.org/blog/2014/04/make-hot-lanes-permanent.html ("There are limited funds to build new freeways and the high cost and prolonged disruption from major road expansions like the current [HOT lane] project on I-405 are front page news.").

214. *See* NHTSA V2V READINESS, *supra* note 72, at 41–42.

215. *Id.*

216. *Id.*

advances may be advisable to enhance autonomous vehicle reliability and safety once a sufficient number of autonomous cars are on the road. However, these infrastructure enhancements will also add to the land use and financial burdens of specialized autonomous vehicle roadway infrastructure.

E. PRIVACY AND SECURITY LAWS

A variety of privacy laws awaits first generation autonomous cars. Security standards for transportation cyberinfrastructure appear to be developing more slowly, despite the fact that security is essential for protection of both personal information as well as autonomous car systems and the safety of users. Both security and privacy aspects of United States law are changing rapidly, but they are currently in very different states of development. Although first generation autonomous cars will have to cope with a great deal of privacy law,[217] security laws and standards for autonomous cars are, at least at present, scarce.[218]

The greatest privacy law challenge for first generation autonomous cars will likely come from having to comply with the plethora of personal information laws that will apply to these new means for personal mobility. Because the function of passenger cars is to move people, autonomous cars will inevitably have considerable personal information associated with them. Examples of personal information associated with first generation autonomous cars will include car ownership and registration information, insurance data, usage data, and location information. Scores of existing state and federal personal information privacy laws, both federal and state, will apply to first generation autonomous cars as they generate, collect and use personal information.[219]

1. Drivers Privacy Protection Act

An interesting, if ironic, example of federal privacy statutes that will govern personal information associated with first generation autonomous cars is the federal Driver's Privacy

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217. Glancy, *supra* note 65, at 1187–1216 (discussing various privacy interests relating to autonomous vehicles).

218. *See* MARKEY, *supra* note 84.

219. Glancy, *supra* note 65, at 1197–99.

Protection Act of 1994 (DPPA).[220] The DPPA protects an individual's personal information held by state motor vehicle departments (motor vehicle records) against disclosure without the written consent of that individual, unless one of fourteen statutory exceptions applies.[221] Protected motor vehicle records are defined as "any record that pertains to a motor vehicle operator's permit, motor vehicle title, motor vehicle registration, or identification card issued by a department of motor vehicles."[222] The DPPA protects not only drivers, but also all individuals whose personal information is contained in state motor vehicle records, including, in the future, people who own and register autonomous cars.[223] Many states have enacted laws similar to the DPPA that protect personal information more extensively.[224]

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220. 18 U.S.C. §§ 2721–2725 (2012). In addition, many states have enacted similar statutes further regulating vehicle ownership and registration information that includes personal information. *See 2014 Security Breach Legislation*, NAT'L CONF. ST. LEGISLATURES (Dec. 23, 2014), http://www.ncsl.org/research/telecommunications-and-information-technology/2014-security-breach-legislation.aspx.

221. 18 U.S.C. §§ 2721–2725. The United States Supreme Court has upheld the DPPA's regulation of state agencies against a Tenth Amendment challenge in Reno v. Condon, 528 U.S. 141 (2000).

222. *Id.* § 2725(1). The statute protects both "personal information" and "highly restricted personal information" against disclosure. *Id.* § 2721(a). "Personal information" is defined as "information that identifies an individual, including an individual's photograph, social security number, driver identification number, name, address (but not the 5-digit zip code), telephone number, and medical or disability information, but does not include information on vehicular accidents, driving violations, and driver's status." *Id.* § 2725(3). "Highly restricted personal information" is defined as "an individual's photograph or image, social security number, medical or disability information." *Id.* § 2725(4).

223. *See id.* § 2721. In 2013, the United States Supreme Court reaffirmed the important privacy protection purposes of the DPPA in a case involving lawyers who improperly obtained DMV records of vehicle purchasers' names and addresses and used that information to send direct mail advertising to potential plaintiffs for a class action against car dealers. Maracich v. Spears, 133 S. Ct. 2191 (2013).

224. *See The Drivers Privacy Protection Act (DPPA) and the Privacy of Your State Motor Vehicle Record*, ELECTRONIC PRIVACY INFO. CENTER, https://epic.org/privacy/drivers/ (last visited Feb. 27, 2014) ("States were required to comply with the minimum requirements of the DPPA by September 1997. Many states are more restrictive than the federal rules.").

2. Fair Information Practices Laws

Moreover, state statutes often require fair information practices as part of state consumer protection laws. Among these state privacy laws, privacy breach (sometimes called "security breach" or "data breach") statutes will be among the most important. Privacy breach statutes have been enacted in forty-seven states.[225] Typically, these laws protect "personal information," such as a person's name combined with social security number, driver's license or state ID, account numbers, or the like.[226] Protection extends to improper disclosures of this personal information through unauthorized access and other types of data losses,[227] although there are often exemptions if the information is encrypted.[228] These statutes require that each individual whose personal information has been improperly disclosed be notified. The cost of such notifications both in terms of money[229] and in terms of business reputation[230] can be substantial. These laws will affect manufacturers, sellers, ride-service companies, indeed, all those who collect personal information in connection with first generation autonomous vehicles.

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225. *Security Breach Notification Laws*, NAT'L CONF. ST. LEGISLATURES (Jan. 12, 2015), http://www.ncsl.org/research/telecommunications-and-information-technology/security-breach-notification-laws.aspx (providing a state-by-state summary of enacted and introduced breach legislation). In addition, the District of Columbia, Guam, Puerto Rico, and the Virgin Islands have enacted legislation requiring notification to individuals of security breaches of information involving personally identifiable information. *Id.*

226. *See id.* (providing an overview of the state security breach statutes and protections).

227. *See id.*

228. *See, e.g.*, FLA. STAT. ANN. § 501.171 (West 2014); CAL. CIV. CODE § 1789.81.5 (West 2014).

229. PONEMON INST., 2014 COST OF DATA BREACH STUDY: UNITED STATES (2014), *available at* http://essextec.com/sites/default/files/2014%20Cost%20of%20Data%20Breach%20Study.PDF.According to the Ponemon Institute study, in 2013, the average cost for each lost or stolen record containing sensitive and confidential information was $201 per record. *Id.* at 5. The total average cost paid by organizations was $5.9 million. *Id.* at 2.

230. *See, e.g.*, Press Release, Semafone, 86% of Customers Would Shun Brands Following a Data Breach (Mar. 27, 2014), *available at* https://www.semafone.com/86-customers-shun-brands-following-data-breach/. In a survey of 2000 respondents, eighty-seven percent of customers responded they would avoid brands following a data breach of credit or debit card personal data. *Id.* Where data breaches to involve home addresses or telephone numbers, eighty-three percent of customers replied that that would not likely do business with the privacy-breaching organization again. *Id.*

3. Communications Privacy

A number of federal communications statutes will also apply depending on the technologies used in first generation autonomous cars, including the Electronic Communications Privacy Act (ECPA).[231] In addition, section 222 of the Telecommunications Act of 1996 may protect the privacy of consumer proprietary network information (CPNI) if first generation autonomous cars use commercial mobile wireless connections.[232] Under the Telecommunications Act of 1996, CPNI refers to "information that relates to the quantity, technical configuration, type, destination, location, and amount of use of a telecommunications service subscribed to by any customer of a telecommunications carrier, and that is made available to the carrier by the customer solely by virtue of the carrier-customer relationship,"[233] as well as telephone bills.[234] A separate provision specifically protects location information.[235] So far, the FCC has been reluctant to enforce these requirements in the context of vehicle communications systems.[236]

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231. Electronic Communications Privacy Act, 18 U.S.C. § 2510–2511 (2012). It is noteworthy that under § 2510(16), the basic safety message (which is not encrypted) would not be protected because, being transmitted in the clear, it is considered to be "readily accessible to the general public."

232. *See* 47 U.S.C § 222(a) (2012) ("Every telecommunications carrier has a duty to protect the confidentiality of proprietary information of, and relating to, other telecommunication carriers, equipment manufacturers, and customers, including telecommunication carriers reselling telecommunications services provided by a telecommunications carrier.").

233. *Id.* § 222(h)(1)(A).

234. *Id.* § 222(h)(1)(B).

235. *Id.* § 222(f) ("For purposes of subsection (c)(1) of this section, without the express prior authorization of the customer, a customer shall not be considered to have approved the use or disclosure of or access to— (1) call location information concerning the user of a commercial mobile service (as such term is defined in section 332(d) of this title) or the user of an IP-enabled voice service (as such term is defined in section 615b of this title), other than in accordance with subsection (d)(4) of this section; or (2) automatic crash notification information to any person other than for use in the operation of an automatic crash notification system.").

236. The FCC's 2015 Open Internet Order indicates the Commission's intention to continue to recognize exceptions for services considered non-BIAS data services (i.e., services that are not "broadband Internet access service" data services). The Open Internet Order refers to "limited-purpose devices such as automobile telematics" as an example of a non-BIAS data service, which the FCC has decided to continue to monitor, rather than regulate as Title II telecommunications services. *See* Protecting and Promoting the Open

4. Law Enforcement Access

Commercial wireless communications to and from first generation autonomous cars will be subject to monitoring by law enforcement under the Communications Assistance for Law Enforcement Act (CALEA).[237] CALEA requires telecommunications carriers to facilitate law enforcement access to telecommunications networks primarily through CALEA solutions switches (usually software) that enable law enforcement interception.[238] In 2005, the FCC, which has jurisdiction to prescribe "such rules as are necessary to implement" CALEA requirements,[239] extended the reach of CALEA requirements to Voice over Internet Protocol (VoIP) and facilities-based broadband.[240] As a result, first generation autonomous vehicles using commercial wireless connections will probably have less privacy protection against law enforcement interception than V2V DSRC communications, to which CALEA does not appear to apply. If first generation autonomous vehicles communicate only over V2V DSRC applications, they will likely avoid having to comply with CALEA law enforcement access. As currently designed, V2V DSRC communications transmit and receive data over private, ad hoc, closed networks that do not interconnect with public telephone systems or the Internet.[241] However, if V2V is extended to V2I, which is connected to the Internet or telephone system, then these DSRC communications would probably be subject to CALEA requirements.[242]

Internet, Report and Order on Remand, Declaratory Ruling, and Order, FCC 15-24, GN Docket No. 14-28 (Mar. 12, 2015), *available at* https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-24A1.pdf.

237. *See* 47 U.S.C. §§ 1001–1010 (2012).

238. 47 U.S.C. § 1002(a)(1). CALEA requires every "telecommunications carrier" to "ensure that equipment, facilities, or services that provide a customer or subscriber with the ability to originate, terminate, or direct communications are capable of—expeditiously isolating and enabling the government, pursuant to a court order or other lawful authorization, to intercept, to the exclusion of any other communications, all wire and electronic communications carried by the carrier within a service area". *Id.*

239. *See* 47 U.S.C. § 229(a).

240. *See* Communications Assistance for Law Enforcement Act and Broadband Access and Services, 20 FCC Rcd. 14989, 14993 (2005).

241. *See* NHTSA V2V READINESS, *supra* note 72, at xviii.

242. The 2005 FCC order extending CALEA to VoIP and facilities-based broadband notes three factors that cause a network to be subject to CALEA compliance: (1) electronic communication switching or transmission; (2)

Of course, other existing privacy-compromising laws permitting law enforcement access to personal information and communications would also likely apply to first generation autonomous car communications. For example, the ECPA (sometimes called the Wiretap Act)[243] permits access by law enforcement to autonomous vehicle communications with a warrant. To the extent that communications providers, manufacturers, and others store autonomous vehicle information, the Stored Communications Act[244] would facilitate law enforcement. Access to such stored data often only requires a subpoena or a "2703(d) order" based on a reasonable belief that the records are relevant and material to a criminal investigation.[245] Decisional law has varied with regard to permitting law enforcement access to mobile device information of telecommunications carriers under the Stored Communications Act.[246]

5. Additional Privacy Legislation

Between now and the arrival of first generation autonomous cars, additional privacy legislation is likely at the federal level. For example, the Fiscal Year 2015 Consolidated and Further Continuing Appropriations Act includes a rider that restricts USDOT from using funds "to mandate global positioning system (GPS) tracking in private passenger motor vehicles without providing full and appropriate consideration of privacy concerns" under the Administrative Procedure Act.[247]

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replacement for local telephone service; and (3) the public interest in CALEA's application. If the second factor, known as Substantial Replacement Provision (SRP), remains most important, V2V communications would not have to comply with CALEA unless the FCC found the third factor, public interest in CALEA's application, to be paramount. Communications Assistance for Law Enforcement Act and Broadband Access and Services, 20 FCC Rcd. 14989, 14993 (2005).

243. 18 U.S.C. § 2511 (2012) (combining with 18 U.S.C. § 2510(16) (2012), which states that encrypted communications are not considered to be "readily accessible to the general public").

244. 18 U.S.C. §§ 2701–2712 (2012).

245. *Id.* § 2703(d).

246. *See* Zachary Ross, *Bridging The Cellular Divide: A Search For Consensus Regarding Law Enforcement Access To Historical Cell Data*, 35 CARDOZO L. REV. 1185 (2014) (discussing the disagreement among courts with regard to 18 U.S.C. § 2703(d) orders).

247. Consolidated and Further Continuing Appropriations Act, 2015, Pub. L. No. 113-235, § 417, 128 Stat. 2130 (2014).

Such a law could restrict the use of federal funds for certain aspects of autonomous car development that involve location tracking using GPS signals. Most experimental autonomous cars already use GPS systems.[248] The funding restriction would withhold USDOT funds from projects that use GPS signals to track autonomous cars.

Federal legislation that focuses on protection of location information has been repeatedly proposed. In the 114th Congress, Senator Ron Wyden and Representative Jason Chaffetz reintroduced the Geolocation Privacy and Surveillance Act (GPS Act), as S. 237 (2015) and H.R. 491 (2015).[249] The GPS Act would prohibit businesses from disclosing geographical tracking data and provides guidelines for when and how geolocation information can be accessed and used.[250] The proposed legislation also requires government agencies to show probable cause warrants to obtain geolocation information.[251] In addition, Representative Zoe Lofgren has reintroduced the "Online Communications and Geolocation Protection Act," H.R. 983, that contains provisions similar to the GPS Act, as well as safeguards for online communications.[252] Because autonomous cars would be prime sources of location information, this proposed legislation, if enacted, would provide additional privacy protection for users of first generation autonomous cars.

A great deal of federal privacy legislation has been introduced in the recent past to control government surveillance.[253] To the extent that individuals using autonomous vehicles become more vulnerable to surveillance, law enforcement agencies, stalkers, and others seeking to track individuals in real time would likely find autonomous cars

248. *See supra* Part III.C.

249. Geolocational Privacy and Surveillance Act, S. 237, 114th Cong. (2015); Geolocational Privacy and Surveillance Act, H.R. 491, 114th Cong. (2015).

250. *See* S. 237 § 2602.

251. *See id.* § 2602(h).

252. *See* Online Communications and Geolocation Protection Act, H.R. 983, 114th Cong. (2015).

253. For example, changes in the ECPA have been repeatedly introduced over the past several congresses. Email Privacy Act, H.R. 699, 114th Cong. (2015); Electronic Communications Privacy Act Amendments Act of 2015, S. 356, 114th Cong. (2015); *see* Electronic Communications Privacy Act Amendments Act of 2015, H.R. 283, 114th Cong. (2015).

useful tools. As a result, federal surveillance legislation may well have been enacted by the time first generation of autonomous cars are on the roads.

Private sector surveillance has only recently become a matter of concern. Surveillance of a person using an autonomous car's electronic systems will depend in part on what technologies and applications are included in first generation autonomous cars and who has access to these systems.[254] Policy concern is already widespread about the potential misuse of information collected by non-autonomous ride services, such as Uber, to track the locations and travels of individuals. Technology writer Peter Sims initiated what became an extended conversation about this issue by asking, "Can we trust Uber?"[255] Sims's question went viral.[256] In November 2014, Senator Al Franken sent a letter to Uber's CEO Travis Kalanick that asked for detailed information about the company's privacy policies and practices, particularly what was known as Uber's "God View" of its patrons, which used the Uber mobile application to track Uber users everywhere they went.[257] Uber answered with a "privacy audit" from a major Washington, D.C., law firm that insisted Uber was using subscriber information for legitimate business purposes and asserted that Uber's "God View" of its patrons was no longer used.[258] This type of controversy makes legal regulation of such private surveillance using ride-service technologies more likely

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254. Senator Markey's report, *Tracking & Hacking*, discloses some of these private sector surveillance problems in connection with vehicle manufacturers' private wireless connections with vehicle computer systems. *See supra* text accompanying notes 84–91.

255. Peter Sims, *Can We Trust Uber?*, MEDIUM (Sept. 26, 2014), https://medium.com/@petersimsie/can-we-trust-uber-c0e793deda36.

256. See Zeynep Tufekci & Brayden King, *We Can't Trust Uber*, N.Y. TIMES (Dec. 7, 2014), http://www.nytimes.com/2014/12/08/opinion/we-cant-trust-uber.html, for an example of the discussion stimulated by Sims's question.

257. Letter from Sen. Al Franken, Chairman, Subcomm. on Privacy, Tech., and the Law, to Travis Kalanick, Chief Exec. Officer, Uber (November 19, 2014), *available at* http://www.franken.senate.gov/files/letter/141119UberLetter.pdf; *see* Douglas Macmillan, *Will Uber's Privacy Updates Satisfy Congress?*, WALL. ST. J. (Feb. 2, 2015, 2:09 PM), http://blogs.wsj.com/digits/2015/02/02/will-ubers-privacy-updates-satisfy-congress. In short, the controversy continues unabated.

258. HOGAN LOVELLS, REVIEW AND ASSESSMENT OF UBER'S PRIVACY PROGRAM 1–2, 17 n.19 (2015), *available at* https://blog.uber.com/wp-content/uploads/2015/01/Full-Report-Review-and-Assessment-of-Ubers-Privacy-Program-01.30.15.pdf.

by the time the first generation of autonomous cars is on the road.

6. Security

Security laws are among the most elusive of the many unknowns regarding laws that will apply to first generation autonomous cars. The technical aspects of security for autonomous cars are not at present well understood by the public, despite the fact that they are vitally important.[259] Ryan Gerdes, a Utah State University researcher, noted that "[s]ecurity in this [autonomous car] realm really just hasn't been touched . . . . Vehicle communication can be jammed, sensors can be jammed, and attackers could try to do just about anything to cause the system to be unsafe."[260] Policy questions about how best to provide security for autonomous cars are only just beginning to be asked. Answers, in the form of legal rules or standards, will need to be in place before first generation autonomous cars can safely move onto public roads.

Some of the interrelationships between security and privacy are reflected in existing regulatory activities of the Federal Trade Commission (FTC). The FTC has brought a series of groundbreaking enforcement actions for "unfair trade practices" against companies that collected personal information but failed to secure it.[261] Because first generation

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259. Autonomous cars will depend on automated control systems that are particularly vulnerable to sophisticated malware. The Stuxnet virus, which became infamous in 2010 for its unprecedented ability to destroy physical infrastructure, is an example of this security threat to autonomous cars. *See* Kim Zetter, *An Unprecedented Look at Stuxnet, The World's First Digital Weapon*, WIRED (Nov. 3, 2014, 6:30 AM), http://www.wired.com/2014/11/countdown-to-zero-day-stuxnet/.

260. Press Release, Utah State Univ. Coll. of Eng'g, Security Questions Abound as Autonomous Vehicles Emerge (Aug. 19, 2014), http://www.engineering.usu.edu/htm/news/articleID=25775 (discussing how "the multi-disciplinary research group will address driverless vehicle system security from bumper to bumper"); *see also* Alexis C. Madrigal, *When Cars Are as Hackable as Cell Phones,* ATLANTIC (Sept. 8 ,2014, 3:55 PM), http://www.theatlantic.com/technology/archive/2014/09/when-cars-are-as-hackable-as-cell-phones/379734/.

261. *See* LabMD, Inc. v. FTC., 776 F.3d 1275 (11th Cir. 2015); FTC. v. Wyndham Worldwide Corp., 10 F. Supp. 3d 602 (D.N.J. 2014). According to the *National Law Journal*, the FTC had settled fifty-three of these security-breach privacy cases through January 2015. Jenna Greene, *FTC Stakes Claim As Data Security Cop*, NAT'L L.J. (Jan. 23, 2015), http://www.nationallawjournal.com/id=1202715977568/FTC-Stakes-Claim-As-Data-Security-Cop.

autonomous cars will be consumer products, they will be subject to similar FTC scrutiny with regard to their privacy practices including the security of personally identifiable information.

Security issues such as those posed by autonomous cars have been under study by the National Institute of Standards and Technology (NIST). High-level guidance for security management applicable to autonomous cars is available in the 2013 comprehensive update to NIST's *Security and Privacy Controls for Federal Information Systems and Organizations*.[262] NIST has also released a 2015 proposed update to its *Guide to Industrial Control Systems (ICS) Security*[263] that provides tailored guidance regarding specialized security needs in such industries as automakers. Appendix G of the *Guide* interrelates updated Industrial Control System security guidance with the 2013 Security and Privacy Controls management system.[264] Although this NIST guidance focuses on federal information systems management, it suggests some of the types of security standards that will need to be in place for first generation of autonomous cars.

In addition, vehicle communications security will be an important consideration for autonomous cars. Assuming that the V2V DSRC safety communications NHTSA intends to mandate are in fact used in first generation autonomous cars, specific security requirements for the resulting V2V ad hoc communications networks will be necessary. The readiness report accompanying NHTSA's 2014 advance notice of proposed rulemaking (ANPRM) with regard to requiring V2V using DSRC[265] sketched a public key encryption security certificate management system (SMS) limited to passenger vehicles and light trucks. However, the suggested SMS lacks detail.

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262. NAT'L INST. OF STANDARDS AND TECH., U.S. DEP'T OF COMMERCE, SECURITY AND PRIVACY CONTROLS FOR FEDERAL INFORMATION SYSTEMS AND ORGANIZATIONS (2013), *available at* http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-53r4.pdf.

263. NAT'L INST. OF STANDARDS AND TECH., U.S. DEP'T OF COMMERCE, GUIDE TO INDUSTRIAL CONTROL SYSTEM (ICS) SECURITY (2015), *available at* http://csrc.nist.gov/publications/PubsDrafts.html#SP-800-82-Rev.2.

264. *Id.* at app. G.

265. Federal Motor Vehicle Safety Standards: Vehicle-to-Vehicle (V2V) Communications, 79 Fed. Reg. 49,270 (proposed Aug. 20, 2014) (to be codified at 49 C.F.R. pt. 571).

Moreover, broader concerns about the security of DSRC data transmissions between autonomous cars and other potential DSRC units not covered in the ANPRM will not apparently be addressed in the anticipated rulemaking. Before the first generation of autonomous cars can be expected to rely on DSRC V2V communications from other cars, robust communications security requirements will be essential.

In addition to communications security, the potential for external control over and manipulation of autonomous cars appears to present somewhat different security challenges. Recent experiments have gained remote access to automated vehicle functions in conventional vehicles.[266] At least a couple of different hacking strategies have been used to seize control over autonomous cars remotely: (1) providing bogus input-information that misdirects the autonomous car to take predictable actions; or (2) taking over autonomous car operations through malware or remote control.[267] Technical research is under way regarding these and other autonomous car security issues.[268] However, no security standards for first generation autonomous cars are yet in place.[269]

First generation autonomous cars will become part of the nation's critical transportation infrastructure and need to contribute to the security of that infrastructure. Legal standards both for privacy and for cybersecurity currently under development must be in place before first generation autonomous cars can safely enter the nation's roadways.

F. A HYPOTHETICAL NATIONAL AUTONOMOUS VEHICLE ACT (NAVA)

A thought experiment may be useful in evaluating the complications of a unified national approach to regulation of first generation autonomous cars. Congress could enact a statute that would apply uniformly nation-wide to first generation autonomous cars and perhaps all other types of autonomous vehicles. The power to enact such a statute would be based on the Congressional power to regulate interstate

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266. John Markoff, *Researchers Show How a Car's Electronics Can Be Taken Over Remotely*, N.Y. TIMES (Mar. 9, 2011), http://www.nytimes.com/2011/03/10/business/10hack.html.

267. MARKEY, *supra* note 84.

268. *Id.*

269. *Id.* at 2.

commerce.[270] Such a statute would be designed to replace the patchwork of state and federal laws discussed earlier in this Article with a uniform national regulatory system. Promoting development and adoption of autonomous vehicle technologies that are much safer than conventional vehicle technologies through reducing legal risks and uncertainties would provide a major policy justification. For the purposes of this thought experiment, it is necessary to suspend judgment about whether such a statute could be enacted.

It would be preferable to make such hypothetical federal legislation applicable to all types of autonomous vehicles, including, but not limited to, the first generation autonomous cars discussed in this Article. First generation autonomous cars will share technical and operational features with other varieties of autonomous vehicles, such as trucks and buses. Moreover, if autonomous vehicles are required to be connected through wireless communication, they would need a single, interoperable communications system.[271] Assume that the hypothetical federal legislation discussed here extends to all types of autonomous motor vehicles, and is called the National Autonomous Vehicle Act (NAVA).

An important purpose of NAVA would be to preempt inconsistent state law and create a uniform national autonomous vehicle legal regime for first generation autonomous cars, as well as other types of autonomous vehicles. To accomplish this, NAVA should contain a strong preemption clause. For example, NAVA might provide: "When regulation of autonomous vehicles prescribed under this chapter is in effect, a State (or a political subdivision of a State) may not adopt or enforce any law, whether it be common law, legislative or regulatory, related to regulation of autonomous vehicles under standards provided in this chapter." This hypothetical preemption clause is unusually sweeping in preempting not only state and local statutes and regulations,

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270. *See* U.S. CONST. art. I, § 8, cl. 3; *see supra* note 170 and accompanying text.

271. Among the problematic features of NHTSA's intended proposal to require DSRC transceivers in new passenger cars and light trucks is that the proposal does not apply to the many other types of vehicles with which first generation autonomous cars will be sharing roadways. *See supra* note 73 and accompanying text.

but also common law rules.[272] Even with such a clear expression of Congressional intent that there is no room for state law in the regulation of autonomous vehicles, the United States Supreme Court remains capable of narrowly construing even such broad express preemption to provide room for state concerns about quite different matters such as car loans or bicycle safety.

In addition to expressly preempting state law, the hypothetical NAVA might also consolidate all federal authority related to autonomous vehicles into a single federal agency. For current hypothetical purposes, the new consolidated agency might be called the Autonomous Vehicle Administration (AVA), which could be made part of USDOT. A statutory provision of this type would have the effect of reorganizing USDOT. Jurisdiction over regulatory programs regarding autonomous vehicles would be transferred from the Federal Motor Carrier Safety Administration, the Federal Transit Administration, the Federal Highway Administration, and NHTSA to the new, highly-focused AVA. Moreover, to the extent that autonomous vehicles will need to communicate reliably without interference, it may be useful to transfer some portion of FCC regulatory authority over autonomous vehicle communications to AVA as part of the reorganization.[273]

The statute would delegate to AVA both legislative and adjudicative power to govern all matters related to autonomous vehicles, including specialized infrastructure needs of autonomous vehicles. Since autonomous vehicles will be able to safely travel much closer together and in much narrower lanes, specialized infrastructure for autonomous vehicles may make sense. AVA would adopt national standards and regulations

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272. This part of the preemption provision reflects lessons learned from Geier v. Am. Honda Motor Co., 529 U.S. 861 (2000) and Williamson v. Mazda Motor of Am., Inc., 130 S. Ct. 3348 (2011).

273. A possible argument for such a jurisdictional transfer from the FCC could be the FCC's expansive plans to regulate the Internet as a public utility. *See* Rebecca R. Ruiz and Steve Lohr, *F.C.C. Approves Net Neutrality Rules, Classifying Broadband Internet Service as a Utility*, N.Y. TIMES (Feb. 26, 2015) *available at* http://www.nytimes.com/2015/02/27/technology/net-neutrality-fcc-vote-internet-utility.html. Such an ambitious regulatory program could sideline regulation of autonomous vehicle communications that would be better handled by AVA. There would of course be a counter-argument that autonomous vehicle use of DSRC needs to be coordinated with other wireless spectrum regulation that would continue to be under the jurisdiction of the FCC.

that would unify legal requirements that apply to autonomous vehicles of all types and in all settings.[274] An agency such as AVA would also provide a central authority to promote, as well as to regulate, deployment of autonomous vehicles in the United States, starting with first generation autonomous cars.

Although state vehicle licensing laws would likely not be completely preempted, all standards for licensing autonomous vehicles would be subject only to uniform national autonomous vehicle standards promulgated as regulations by AVA. Civil and criminal liability standards for cases involving autonomous vehicles would also be governed by NAVA and regulations under it. In particular, state automobile insurance laws that might otherwise apply to autonomous vehicles would be replaced by a national autonomous vehicle insurance system (NAVIS), perhaps a national no-fault system for autonomous vehicles managed by AVA. One unexpected consequence of NAVA's uniform national regulation might be the increased federalization of traffic laws, a legal arena that historically has been the province of state and local governments.[275] Even without eliminating state and local traffic laws, it should be possible to prevent discrimination against autonomous vehicles.

NAVA would also establish a body of federal autonomous vehicle privacy protection requirements to preempt the plethora of state privacy laws that would otherwise apply to the first generation of autonomous cars. This federal autonomous vehicle privacy law might even pave the way for more extensive federal regulation of personal information practices in other areas of commerce, such as Internet transactions. Establishing enhanced security standards by regulations adopting requirements for autonomous vehicles similar to those devised by NIST would be among the likely benefits of NAVA's national approach to governing autonomous vehicles.

Of course, Justice Brandeis's characterization of legal regulation by states as laboratories of democracy[276] may

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274. Ultimately, the AVA might expand its regulatory jurisdiction to include autonomous vehicles that operate in the air and water. However, initially it would be more effective to focus on ground vehicles.

275. *See supra* text accompanying notes 122–26.

276. New State Ice Co. v. Liebmann, 285 U.S. 262, 311 (1932) (Brandeis, J., dissenting) ("[A] single courageous state may, if its citizens choose, serve as a

suggest caution about this thought experiment. NAVA may appear to be an extreme effort to overregulate and standardize an emerging technology (or group of technologies) before even better designs and practices have evolved. AVA's extensive regulatory measures at this nascent stage of autonomous vehicles, before even the first generation autonomous vehicles are on the road, may be counterproductive to the development of autonomous vehicles. At present, autonomous vehicle technologies seem to be developing in diverse ways and in diverse places, under relatively low levels of regulation or standardization. First generation autonomous cars will be a product of such a diffused development process, unless legislation like NAVA is enacted very soon.

Nevertheless, this thought experiment regarding a hypothetical NAVA illuminates some of the policy issues first generation autonomous cars, and other types of autonomous vehicles that follow them, will encounter. Considering at least some potential for a federal unifying role in what is now a legal ecosystem fraught with diversity and uncertainty may expedite entry of first generation autonomous cars onto United States roads.

VI. CONCLUSION

Right now, commercial versions of autonomous cars are not yet on the market. One of the challenges of writing an Article such as this is that it requires speculation about the future of both technology and law. At the moment, to borrow a phrase from Gertrude Stein (famously referring to her hometown of Oakland, California), "there is no there there."[277] In the case of autonomous cars, there are prototypes and experimental versions. But there are no commercial versions of autonomous cars for people to purchase, and for the law to govern and to regulate.

Whether and how the first generation of autonomous cars will deliver anticipated safety and convenience in personal mobility is yet to be seen. Urban environments pose challenges of unpredictable roadways and erratic roadway users that autonomous cars do not need. Rural environments often lack

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laboratory; and try novel social and economic experiments without risk to the rest of the country.").

277. GERTRUDE STEIN, EVERYBODY'S AUTOBIOGRAPHY 289 (1937).

dynamic digital maps that autonomous cars need to operate. Already chronically short of funds,[278] public highway infrastructure probably cannot now afford to provide special, protected travel lanes just for autonomous cars. These and other challenges will greet the first generation of autonomous cars sometime within the next decade. How soon and how smoothly those first autonomous cars will be accepted on United States roads and highways will depend in part on first solving some of the many legal puzzles explored in this Article.

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278. *Highway Trust Fund Ticker*, U.S. DEP'T TRANSP., http://www.dot.gov/highway-trust-fund-ticker (last updated July 8, 2015).

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