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A LOOK AT THE LEGAL ENVIRONMENT FOR DRIVERLESS VEHICLES

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The Problem and Its Solution

State highway departments and transportation agencies have a continuing need to keep abreast of operating practices and legal elements of specific problems in highway law. This report continues NCHRP's practice of keeping departments up-to-date on laws that will affect their operations.

Applications

Sometime within the next decade, driverless vehicles will join conventional vehicles, which are operated by human drivers, on the roads of the United States. How many people will decide to forego human driving for driverless vehicles is a matter of wide speculation. Many drivers will likely stay with conventional cars for a time. After all, given advancing technology, in the near future conventional vehicles will be highly automated, capable of limited self-driving, partially autonomous, and probably connected. Nevertheless, even if driverless vehicles are adopted only gradually and partially, their introduction onto roadways still will have numerous legal ramifications.

How soon and how smoothly driverless vehicles merge onto U.S. roads and highways will depend, in part, on how the legal system resolves the many legal issues implicated by these vehicles. Driverless vehicles will inherit a framework of laws designed for conventional vehicles. Some states already have begun to make minor modifications to this framework to account for the unique capabilities and concerns associated with driverless vehicles. In the future, these intersections of the law and driverless technologies will grow increasingly numerous and complicated.

This digest has been prepared to assist policymakers in anticipating, working through, and resolving the legal policy issues that may be associated with driverless vehicles. It provides policymakers with an introduction to how civil and criminal liability may adhere to driverless vehicles, the implications of these vehicles for privacy and security, how these vehicles are likely to become subject to and potentially alter prevailing automobile insurance regimes, and other related topics.

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A LOOK AT THE LEGAL ENVIRONMENT FOR DRIVERLESS VEHICLES

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I. INTRODUCTION

Driverless vehicles have been predicted, promised, and desired for decades. Finally, technologies necessary to realize these devices have become available. The question is no longer if, but when, driverless vehicles will become available to the public. When they do, driverless vehicles will transform ground transportation in the United States and around the world.

Capable of operating without human control over their operation, driverless vehicles are anticipated to have numerous advantages in terms of safety, convenience, mobility, and environmental protection, relative to their conventional counterparts. By freeing up what would otherwise be a driver for other tasks, driverless vehicles may increase the productivity of their users. The enhanced awareness and reaction capabilities of these vehicles eventually should result in thousands of saved lives and avoided vehicle crashes. Intelligently coordinating the movements of driverless vehicles should eliminate or at least mitigate traffic congestion, air pollution, and human frustrations incident to everyday driving.

Full realization of these benefits, however, will require modifications to some prevailing legal principles that expect motor vehicles to have drivers in control. Conventional motor vehicles operated by human drivers are subject to an elaborate architecture of legal rules. These rules cover such topics as how these vehicles are to be designed, manufactured, sold, repaired, and used; how liability should be assigned for injuries caused by these devices; the sorts of misconduct that will be regarded as criminal; automobile insurance; and the appropriate uses of land for roads, highways, and other transportation infrastructure. Driverless vehicles will lead to changes in some of these rules, particularly those that at present may not fully account for how these devices operate.

This report discusses the legal environment that will apply to driverless vehicles. The sections that follow consider how driverless vehicles may fit within or challenge existing rules, and, as relevant and appropriate, suggests how these rules could be modified to better serve the public interest. As a forward-looking analysis, this discussion is necessarily

speculative, and relies on numerous assumptions regarding matters including how driverless vehicles will operate and how long it will take for them to come into common use. Nevertheless, even at this early juncture, policymakers should benefit from an assessment of how driverless vehicles mesh with the prevailing legal order.

Policymakers should appreciate the variety of tools at their disposal as they decide how to anticipate and respond to driverless vehicles. Legal policies within this sphere may take the form of restrictions, permitting, bonding, rules of the road, product or performance standards (be they design-based, harm-based, or technology-based), criminal penalties, civil liability (either in the form of fines payable to the government or liability to third parties), social insurance programs, knowledge-building and technical assistance, rewards and subsidies, advance-planning requirements, or mandatory reporting rules.¹ Other regulatory policies may modify the environment in which a technology is used and manage both awareness and expectations that surround the technology. Alternatively, policymakers may choose to defer to market mechanisms and emerging social norms, as well as industry self-regulatory initiatives. Some of these tools are standard, others more exotic. To a significant extent, past practice will provide inertia and experience that will steer policymakers toward particular policy responses regarding driverless vehicles; the law often looks backward to provide rules for the present and future.

Following this introduction, this report will examine in Section II how policymakers of the past addressed some of the challenges associated with once-novel technologies such as railroads, steam-boats, airplanes, and conventional automobiles. Section III of the report will provide an overview of the characteristics of driverless automobiles. Section IV then considers how prevailing civil liability rules may apply to driverless vehicles, while Section V estimates how criminal liability may adhere to their use and misuse. Section VI addresses how these vehicles will be insured, and the changes they may

¹ For a discussion of these policy tools, see U.S. CONGRESS, OFFICE OF TECHNOLOGY ASSESSMENT, ENVIRONMENTAL POLICY TOOLS: A USER'S GUIDE, OTA-ENV-634, U. S. GOVT. PRINTING OFFICE, WASHINGTON, D.C. (1995).

produce in the insurance market. Section VII turns to the privacy and security implications of driverless vehicles and the imperative of building both security and privacy into driverless vehicles. Section VIII discusses federal, state, and local legislation and administrative regulation of driverless vehicles. Section IX then considers sustainability in terms of land, environment, and infrastructure resources. Finally, Section X offers some brief concluding thoughts.

II. NEW TECHNOLOGIES AND LEGAL CHANGE: A BRIEF HISTORY

The likelihood that driverless vehicles soon will appear on the nation's roads raises questions about the application of existing legal rules to these devices, and whether these vehicles may lead to significant changes in the prevailing legal culture. In forecasting these matters, past policymaking experiences may provide some guidance.

Driverless vehicles represent the latest in a long series of transportation and systems technologies that have challenged the creativity and foresight of policymakers. Many of the legal questions that surround driverless vehicles would be familiar to lawmakers of centuries ago, even though the precise technologies involved are different. For example, the first detailed legal code drafted in colonial America, prepared in Massachusetts in the 1640s, addressed prevailing modes of transportation by adopting a franchise system for ferries,² directing towns to appoint persons to build highways "from time to time,"³ and devising an inspection and repair scheme for ships built within the colony.⁴ Since then, federal, state, and local policymakers have continued to engage with new transportation and communications technologies.

A complete history of the interplay between the law and these innovations lies beyond the scope of this report.⁵ A discussion of government interaction with railroads in the 1800s, on its own, could fill a bookshelf. Furthermore, due to changed conditions and the unique qualities of new technologies, much of this history would offer little of value to today's and tomorrow's policymakers. The discussion below therefore follows a different approach in introducing the policy challenges that can be associated with

² THE LAWS AND LIBERTIES OF MASSACHUSETTS 22, 1648 (Harvard Univ. Press 1929).

³ *Id.* at 25.

⁴ *Id.* at 48.

⁵ For a thorough discussion of one component of this story—how federal and state governments have sponsored canal and railroad operations in this country—see Paul Stephen Dempsey, *Transportation: A Legal History*, 30 TRANS. L.J. 235 (2003).

new technologies. It considers how federal, state, and local policymakers addressed a particular issue—the perception and management of risk—associated with transportation, communications, and other important technologies of both yesterday and today. From this discussion, some broad principles emerge regarding how new technologies get absorbed within the prevailing legal order, even as they produce changes in this system. These principles may provide a basis for anticipating policymaking trends and best practices regarding driverless vehicles.

A. Steamboats

In Colonial America, "[e]xperience and common sense overwhelmingly dominated the management of risk."⁶ Colonies enacted laws designed to reduce the risks associated with some basic technologies, such as fire.⁷ But it was not until after the formation of the United States and the appearance of steamboats on the new nation's rivers that a modern technology generated a comprehensive regulatory response.

Steamboats permitted brisk travel over water routes—but at a price, as their high-pressure boilers were prone to explode. These explosions were dangerous in their own right, and often led to the sinking of the affected ships. In 1838 alone, 14 boiler accidents resulted in the loss of 496 lives.⁸ In one of these incidents, boilers aboard the steamboat *Moselle* exploded while that ship plied the Ohio River near Cincinnati in April 1838, resulting in approximately 150 deaths.⁹

The frequency and notoriety of boiler accidents led some states to enact laws to improve steamboat safety. These laws sought to achieve this goal in different ways. An 1837 South Carolina statute provided that a steamboat captain was guilty of a misdemeanor either when their negligence led to physical injury or (regardless of negligence) when an exploding boiler led to such injuries, unless the explosion was shown to be unavoidable.¹⁰ A slightly more elaborate Illinois statute of that same year mandated that steamboat boilers and other equipment be "at all times in good and safe order and

⁶ ARWEN P. MOHUN, RISK: NEGOTIATING SAFETY IN AMERICAN SOCIETY 3 (2012).

⁷ E.g., An Act in Addition to the Several Acts Heretofore Made Relating to Common Nuisances, 1740 Mass. Acts 322.

⁸ John G. Burke, *Bursting Boilers and the Federal Power*, 7 TECH. AND CULTURE 1 (1966).

⁹ *Id.* at 15; REPORT OF THE COMMITTEE APPOINTED BY THE CITIZENS OF CINCINNATI TO ENQUIRE INTO THE CAUSES OF THE EXPLOSION OF THE MOSELLE 18–22 (1838) (hereinafter "MOSELLE REPORT").

¹⁰ An Act to Provide Punishment for the Negligent Management of Steam-Boats, ch. 11, § 1, 1837 S.C. Acts 26, 26–27.

condition,”¹¹ made the masters and owners of boats jointly and severely liable for damages occasioned by their failure to maintain their equipment in good condition,¹² and specified that engaging in steamboat racing represented a misdemeanor.¹³

The federal government adopted an even more comprehensive approach toward the bursting-boiler problem, enacting a statute that combined a licensing regime with the prospect of criminal and civil liability. Proposals to regulate steamboat boilers had circulated in Congress as early as 1824, but it took 14 years for a law to pass.¹⁴ The statute that emerged in 1838, shortly after the *Moselle* disaster, required semiannual inspections of a steamboat’s boilers and annual inspections of the rest of the boat, to be performed by an inspector appointed by the local district court.¹⁵ Only steamboats that passed this inspection would receive the license required for operation of the vessel.¹⁶ The law also demanded that steamboats have “a competent number of experienced and skillful engineers” on board.¹⁷ Another provision within this law specified that it would be regarded as criminal manslaughter when a steamboat employee’s “misconduct, negligence, or inattention” caused a loss of “the life or lives of any person or persons on board.”¹⁸ Finally, the statute provided that in civil lawsuits against steamboat proprietors alleging injuries to persons or property from a steamboat accident, the bursting of a boiler or the escape of steam from a boiler would be regarded as *prima facie* (sufficient) evidence of negligence.¹⁹

The 1838 law proved ineffective at abating steamboat boiler explosions.²⁰ Many of the law’s requirements were vague and difficult to enforce. Shortly after the federal law was enacted, a Cincinnati committee tasked with writing a report on the *Moselle* disaster lamented that Congress had not been more

¹¹ An Act to Prevent Disasters on Steamboats Navigating the Waters within the Jurisdiction of Illinois, § 1, 1837 Ill. Laws 89, 89–90.

¹² *Id.* § 4.

¹³ *Id.* § 5.

¹⁴ Burke, *supra* note 8, at 9.

¹⁵ An Act to Provide for the Better Security of the Lives of Passengers on Board of Vessels Propelled in Whole or in Part by Steam, ch. 191, §§ 4–6, 5 Stat. 304, 305 (1838) (this statute hereinafter being referred to as the “1838 Federal Steamboat Act”).

¹⁶ 1838 Federal Steamboat Act §§ 2, 6.

¹⁷ *Id.* § 6.

¹⁸ *Id.* § 12.

¹⁹ *Id.* § 13. This provision was of little consequence when passengers died, since the prevailing rule at the time was that a person’s tort claims died with them, and there were no wrongful-death statutes then in place.

²⁰ Burke, *supra* note 8, at 18.

specific in its directives. As an example, the report observed that the federal law did not impose any specific design requirements on boilers, such as a requirement that they incorporate safety valves.²¹ The inspection scheme within the federal law also contained at least one major flaw. Inspectors were to be paid by steamboat owners,²² which provided an incentive for lax or nonexistent inspections. The law also failed to specify what it meant by a “skillful” engineer, rendering toothless the requirement that such a person be present onboard.

The ineffectiveness of the 1838 law led Congress to adopt a more comprehensive regime 14 years later. The 1852 statute was more specific than its predecessor had been in the tests that inspectors were to administer in the certification process²³ and the characteristics that boilers had to possess in order to pass inspection.²⁴ These new, more certain requirements capitalized on research on best practices in boiler construction that had been performed years before at the Franklin Institute in Philadelphia.²⁵ The law also sought to address the problem of fraudulent safety certifications by directing that inspectors were to make their certifications in court and under oath.²⁶ The more rigorous character of this revamped regulatory regime has been credited with the ensuing decline in deaths caused by steamboat boiler explosions.²⁷

B. Railroads

If steamboats provided federal and state lawmakers with an introduction to the challenges that can be associated with a new technology, railroads offered a crash course on this subject.

The first locomotive-powered railroad service in this country commenced operation in 1830. Within a decade, there already had been several fatal railroad collisions and derailments.²⁸ Consistent with the generally positive views that Americans held toward railroads early in their history,²⁹ these accidents generally were attributed to isolated misbehavior by

²¹ MOSELLE REPORT, *supra* note 9, at 71, 73.

²² 1838 Federal Steamboat Act, *supra* note 15, § 4.

²³ An Act to Amend an Act Entitled, “An Act to Provide for the Better Security of the Lives of Passengers on Board of Vessels Propelled in Whole or in Part by Steam,” ch. 106, § 9, 10 Stat. 61, 63–66 (1852) (this statute hereinafter being referred to as the “1852 Federal Steamboat Act”).

²⁴ 1852 Federal Steamboat Act § 14.

²⁵ Burke, *supra* note 8, at 12–14.

²⁶ 1852 Federal Steamboat Act, *supra* note 23, § 9.

²⁷ Burke, *supra* note 8, at 22.

²⁸ See SOUTHWORTH ALLEN HOWLAND, STEAMBOAT DISASTERS AND RAILROAD ACCIDENTS IN THE UNITED STATES 238–64 (1840).

²⁹ See MOHUN, *supra* note 6, at 95 (discussing this attitude).

railroad management and employees, as opposed to flaws endemic in railroad operations.³⁰

A spate of accidents in the 1850s³¹ placed railroad dangers in sharper focus. An April 1852 editorial in the *American Railroad Journal* observed that “accidents’ are becoming so alarmingly frequent, they should receive attention for the purpose of devising some way of preventing them, if for no other.”³² The editors continued:

The only way to prevent accidents, is to make it for the interest of railroad companies that they should NOT happen; to make the penalty so great, that freedom from them shall be necessary for economy’s sake. All corrective measures, in fact, resolve themselves into this. The Legislature should not only see that a proper penalty is annexed to every accident, but the public should take the matter into their own hands, by giving exemplary damages in all cases that come before a jury.³³

The editors also observed that “[t]he introduction of railroads has been so recent, that legislation has by no means kept pace with their development, nor with the necessity of providing for the public safety.”³⁴ To fill this gap, the editorial looked toward the recently revised federal steamboat law in urging that:

No material should be used upon railroads, upon which the lives or safety of the travelers may depend, without being subjected to the inspection of some competent person. We adopt this precaution as far as the engines and boilers of a steamboat are concerned; why should we not extend the same to the locomotive, to the running stock, rails, etc., etc.?³⁵

An 1853 report on the causes and means to avoid railroad accidents, prepared at the behest of the New York State Senate, similarly underscored the then-ongoing transition from the previously prevailing tendency to blame railroad accidents on human errors toward a greater appreciation of how the rail system itself might be designed to reduce both the likelihood and the consequences of these mistakes. While the report continued to emphasize human agency, observing, “From the enumeration of the various causes of accidents, it will readily appear how much their prevention depends on the faithful and prompt discharge of the duties devolving upon the agents entrusted with, or in charge of the

³⁰ See HOWLAND, *supra* note 28, at 238–64.

³¹ One author has determined that railroads resulted in 913 deaths in the state of New York alone between 1850 and 1852. Of the persons killed, 321 were railroad employees, 177 were passengers, and 415 were others, such as persons struck at crossings or while walking along the tracks. MARCH ALDRICH, DEATH RODE THE RAILS: AMERICAN RAILROAD ACCIDENTS AND SAFETY, 1828–1965, at 19 (2006).

³² *Accidents on Railroads*, AMERICAN RAILROAD JOURNAL, Apr. 10, 1852, at 234.

³³ *Id.*

³⁴ *Id.*

³⁵ *Id.*

numerous departments of railroad management,”³⁶ it also associated accidents with more technical causes, such as the use of inferior materials and poor route designs.³⁷ Ultimately, however, this report did not recommend any specific safety precautions or remedies. The authors proposed only heightened disclosure requirements for railroads, and that the state investigate any accidents that resulted in casualties.³⁸ Indeed, it would take several decades for state or federal legislators to impose meaningful safety regulations on railroads.³⁹

Until then, courtrooms represented the principal forum in which railroad-safety issues were presented and decided. Rail operations were associated with a remarkable variety of accidents and injuries, from derailments to collisions to fires to railyard mishaps far away from any moving train. These episodes produced an unprecedented number of injured plaintiffs suing in tort. It soon became clear that the likelihood that a plaintiff would recover in such a case depended in large part on their status as a railroad passenger, railroad employee, or someone who lacked a contractual relationship with the railroad.

When pressing personal injury lawsuits against rail operators, passengers inherited a set of favorable rules that ascribed strict liability (in other words, liability without fault) to “common carriers” of goods or property. These rules were adjusted to

³⁶ REPORT OF THE COMMITTEE OF THE NEW YORK SENATE & STATE ENGINEER ON RAIL ROAD ACCIDENTS 12 (1853).

³⁷ *Id.* at 3–7.

³⁸ *Id.* at 21.

³⁹ Some states did require that early railroad enterprises exercise some basic precautions vis-à-vis non-users, such as persons and livestock that crossed railroad lines. One law, passed in 1849 in Vermont, required railroads to erect fences, install cattle guards at farm crossings, and place signs reading “Look out for the engine” at each road crossing. An Act in Relation to Railroad Corporations, §§ 39, 44, 1849 Vt. Acts & Resolves 30, 40, 41. Some early state laws regulating rail operations also imposed speed limits at crossings and where railroads proceeded through cities. E.g., An Act to Restrict Railroad Companies, and to Make Them Liable in Certain Cases, ch. 25, § 1, 1850 Miss. Laws. 96, 96 (imposing a speed limit of 6 mi an hour on railroads operating within cities and towns); An Act to Incorporate the Union Railroad Company, ch. 296, § 6, 1848 Mass. Acts 773, 774. But state legislatures hesitated to prescribe other types of safety regulations, particularly those that would require railroads to replace their infrastructure or utilize specific safety equipment. See STEVEN W. USSELMAN, REGULATING RAILROAD INNOVATION: BUSINESS, TECHNOLOGY, AND POLITICS IN AMERICA, 1840–1920, at 122–23 (2002). The federal government did not fill this void. The first important federal safety law regarding railroads, the Safety Appliance Act, was passed in 1893. JAMES W. ELY, JR., RAILROADS AND AMERICAN LAW 217 (2001).

impose upon railroad companies a high, if not absolute standard of care.⁴⁰ As railroad historian James Ely has observed, “Liability for injury to passengers was based on negligence, but the happening of an accident raised a *prima facie* presumption of fault by the carrier. The burden of proof was then placed on the company to demonstrate its freedom from blame.”⁴¹ Some states also recognized new types of claims for the benefit of deceased passengers’ next of kin, taking the first step toward modern “wrongful death” laws.⁴² A Massachusetts law of this type, enacted in 1840, allowed a widow or other heir to recover between \$500 and \$5,000 when the negligence or recklessness of a proprietor or employee of a railroad, steamboat, stagecoach, or other common carrier led to the death of a passenger.⁴³

Railroad employees were less fortunate,⁴⁴ as their employers could invoke any or all of three potent defenses to their tort lawsuits—contributory negligence, assumption of the risk, and the “fellow servant” rule.⁴⁵ The first of these doctrines barred recovery if the plaintiff’s own negligence contributed to his injury; the second defeated a claim when the plaintiff was regarded as having voluntarily exposed himself to a known risk of harm; and the third exonerated the employer when the plaintiff’s injury was attributable to the fault of a coworker.⁴⁶ The doctrines of contributory negligence and assumption of the risk predated railroads. But railroads introduced the fellow servant rule to this country; the doctrine was first applied in the United States in the early 1840s, in cases brought by railroad employees against their employers.⁴⁷ These three defenses made it impossible for many injured railroad employees to recover for on-the-job injuries throughout the 1800s. It was only in the first decade of the 1900s that Congress addressed railroad workers’ plight by passing legislation that abrogated the fellow servant and contributory-negligence defenses and pared back the assumption of the risk defense in

⁴⁰ ELY, *supra* note 39, at 219. See also EDWARD L. PIERCE, TREATISE ON AMERICAN RAILROAD LAW 469–70 (1857).

⁴¹ ELY, *supra* note 39, at 220.

⁴² Ashley N. Biermann, *The Practical Effects of Dickhoff v. Green on Wrongful Death Actions in Minnesota: Drawing a Line in the Sand or Committing to a Fair Solution?* 40 WM. MITCHELL L. REV. 1543, 1547 (2014).

⁴³ An Act Concerning Passenger Carriers, ch. 80, 1840 Mass. Acts 224.

⁴⁴ See ELY, *supra* note 39, at 213 (observing that “the legal system made it difficult for injured employees or their dependents to recover against railroads”).

⁴⁵ *Id.* at 216.

⁴⁶ *Id.* at 214.

⁴⁷ *Id.*

negligence actions brought by railroad employees against their employers.⁴⁸

Finally, an extensive and complex body of law came to surround the myriad other fact patterns that led to tort lawsuits against railroads. Several of these principles evolved over time, as judges grew more familiar with the hazards associated with the growing railroad network. For example, in the 1800s persons injured while straying onto railroad property often found it difficult to recover because the law of that era classified them as “trespassers,” to whom the railroads owed no duty of care.⁴⁹ Beginning in the mid-1800s, however, courts started to permit recovery when a trespassing child had been drawn onto the railroad’s premises by a turntable or other perceived plaything. These cases that divined and applied the “turntable doctrine” would provide the foundation for a broader principle commonly known today as the “attractive nuisance” rule.⁵⁰

C. Telegraphy

Although not a transportation technology, telegraphy involved the creation of a complex communications system that represents a distant ancestor to the networks that some observers forecast as integral to the operation of driverless vehicles.

Early laws concerning telegraphy tended to evince an optimistic, “booster” attitude toward this technology. Some of these statutes sought to promote telegraph service by making it a crime to maliciously destroy telegraph poles, wires, or other property used for telegraph transmission.⁵¹

But telegraphy involved risks of its own. These dangers were more subtle than the crashes and mangled limbs linked to railroad operations. One hazard was that a telegrapher would make an important mistake in relaying a message. When this happened, the sender or recipient sometimes brought a lawsuit for damages. In these cases, just as railroads were, telegraph companies quickly were classified under the law as “common carriers” and thereby made subject to a heightened standard of care in transmitting messages for their customers.⁵²

Other concerns about telegraphy implied malevolence instead of mere negligence. Unlike traditional

⁴⁸ *Id.* at 218–19 (discussing the Federal Employers Liability Act, ch. 149, Pub. L. No. 60-100, 35 Stat. 65 (1908) (codified as amended at 45 U.S.C. §§ 51–60 (2012))).

⁴⁹ ELY, *supra* note 39, at 221.

⁵⁰ See WILLIAM L. PROSSER, HANDBOOK OF THE LAW OF TORTS § 76 (2d ed. 1955) (discussing these doctrines).

⁵¹ E.g., An Act Relating to the Electro Magnetic Telegraph, ch. 183, 1846 Me. Laws 171.

⁵² See generally *The Liability of Telegraph Companies*, 2 AM. L. REV. 615 (1868) (providing an overview of early caselaw concerning the liability of telegraph companies).

letters that were sealed in envelopes, the contents of messages sent over telegraph wires had to be disclosed to intermediaries. Fears that these middlemen might misuse the information they obtained, or that interlopers might eavesdrop on transmissions or engage in “wiretapping,” led states to adopt criminal laws to deter this sort of unwelcome intermeddling. These concerns flowered so quickly that in 1861—just 17 years after Samuel Morse transmitted the message “What Hath God Wrought” from Washington, D.C., to Baltimore—the territory of Nevada⁵³ criminalized all of the following within its very first batch of laws: divulging the contents of a confidential message,⁵⁴ willfully altering or forging a message,⁵⁵ misappropriation of information contained in a message,⁵⁶ refusing to transmit or unreasonably delaying the transmission of a message,⁵⁷ improper opening or receipt of a telegraph message,⁵⁸ efforts to learn the contents of a message through eavesdropping or wiretapping,⁵⁹ and bribing a telegraph employee to divulge the contents of a message.⁶⁰

D. Electricity

The use of electrical networks for lighting also sparked significant public safety concerns. Even at the start of the electrical age it was commonly understood that electricity spelled danger, at least if insufficient precautions were taken. An 1881 editorial in a Sacramento, California, newspaper observed that “[t]he extension of use of electricity has introduced a new danger to civilization. Wherever houses are lighted by electricity, and in fact wherever powerful currents are carried on wires in and about houses, the danger of fire also arises, and also the danger of injury to those who may happen to touch those wires unawares.”⁶¹

The accumulating mass of electrical wires that cast shade upon many urban streets presented an especially conspicuous manifestation of the dark side of electric lighting. In New York City, the first electric street lamp appeared in 1880.⁶² Just 3 years later,

⁵³ An Act for the Regulation of the Telegraph, and to secure Secrecy and Fidelity in the transmission of Telegraphic Messages, ch. 23, 1861 NEV. STAT. 4623.

⁵⁴ *Id.* § 1.

⁵⁵ *Id.* §§ 1, 2.

⁵⁶ *Id.* § 3.

⁵⁷ *Id.* § 4.

⁵⁸ *Id.* § 5.

⁵⁹ *Id.* § 6.

⁶⁰ *Id.* § 7.

⁶¹ *Electric Fires*, SACRAMENTO DAILY RECORD-UNION, Oct. 27, 1881, at 2. See also *Perils of the Electrical Light Wires*, THE EVENING STAR (Washington, DC), Oct. 22, 1881, at 7.

⁶² *Rapid Advance in Electrical Lighting*, N.Y. TIMES, Jan. 1, 1886, at 4.

The New York Times warned, “Conflagration and death are threatened by every inch of the big arc light wires, of which hundreds of thousands of feet are strung up all over the City. They are a constant menace to the lives of those who walk beneath them.”⁶³

It was generally understood that these overhead wires would present less of a hazard if they were properly insulated⁶⁴ and repositioned underground. In 1885, the New York state legislature assigned the task of relocating Manhattan’s overhead wires to a board of commissioners. Resistance from some lighting companies, who objected to the expense of relocation, together with the board’s corruption and incompetence meant that thick lattices of wires remained strung overhead in Manhattan throughout the 1880s. Worsening the situation, some of these wires were hung in a “criminally loose manner” and had inadequate or nonexistent insulation.⁶⁵

It would require a few high-profile electrocutions to move the wires below the earth. A total of 17 accidental electrocutions occurred in New York City between May 1887 and September 1889.⁶⁶ This death toll was not particularly high for the era, at least relative to the headcounts produced by other perils. According to the New York City coroner, in 1889 4 times as many Gothamites died from falling objects as from electricity, almost 20 times as many died from drowning, and 30 times as many died from falls.⁶⁷ But the horrific nature of a death by electrocution tended to attract attention, and the omnipresence of the overhead wires led to widespread worries that a deadly shock could await anyone below.⁶⁸ One especially dreadful accident occurred in October 1889, when a lineman was electrocuted in the wires strung a block from City Hall. His smoldering corpse remained aloft for an hour while a crowd amassed below. This electrocution came close on the heels of two other fatal accidents, and the public had had enough.⁶⁹ After 2 months of courtroom wrangling with the electric companies, the city received permission to treat dangerous wires as a nuisance, and to cut them

⁶³ *Sudden Death in the Air*, N.Y. TIMES, Nov. 4, 1883, at 6.

⁶⁴ The New York Board of Fire Underwriters prepared a code in 1881 that recommended proper insulation of wires, among other safety measures. *National Electrical Code History*, THE STANDARD, Oct. 28, 1922, at 682.

⁶⁵ Joseph P. Sullivan, *Fearing Electricity: Overhead Wire Panic in New York City*, IEEE TECHNOLOGY AND SOCIETY MAGAZINE, Autumn / Fall 1995, at 8, 9 (quoting an address given by Dr. George H. Benjamin).

⁶⁶ *Id.*

⁶⁷ *Id.*; *The Year that Has Gone*, N.Y. TIMES, Jan. 2, 1890, at 2.

⁶⁸ Sullivan, *supra* note 65, at 11.

⁶⁹ *Id.* at 10–11.

down.⁷⁰ The city began to take down hazardous wires the very next day,⁷¹ in certain spots doing so in front of applauding crowds.⁷² By the end of the year, roughly one-quarter of the city's overhead wires had been removed.⁷³

Removing the wires led to the temporary darkening of some city streets. There had been 1,328 electric street lights in use in New York City as of December 31, 1888; that number fell to just 145 precisely 1 year later.⁷⁴ But the public's anger was directed at a specific practice—unsafe overhead wiring—as opposed to electric lighting in general. As wires were moved underground,⁷⁵ electric streetlamps soon returned to city streets. By the end of 1892, there were 1,539 such lamps in use, and this number would almost double within another 4 years.⁷⁶

E. Automobiles

Highway travel has always been somewhat hazardous. The New York City coroner's report for the year 1889 counted 12 accidental deaths where people had been "run over by horse cars," 33 deaths under the heading "run over by cars and engines," and 32 persons who had been "run over by wagons and trucks."⁷⁷ The equivalent report for 1909 still attributed far more accidental deaths to horses and horse-drawn vehicles than to automobiles.⁷⁸ But by 1919, automobile fatalities within the city had surged to a level several times greater than that ever associated with horses.⁷⁹ The carnage associated with automobiles continued to climb during the Roaring Twenties, when automobile usage spiked. By 1929, automobiles were linked to approximately 30,000 deaths annually.⁸⁰ This headcount is similar to that of today—a striking total, given that the

⁷⁰ A Nuisance Has No Rights, N.Y. TRIBUNE, Dec. 14, 1889, at 1.

⁷¹ Sullivan, *supra* note 65, at 13.

⁷² At 'Em at Last, THE EVENING WORLD (NY), Dec. 14, 1889, at 1.

⁷³ Sullivan, *supra* note 65, at 13.

⁷⁴ *Id.*

⁷⁵ The process of moving the wires underground, however, would not be complete until 1905. *Id.* at 14.

⁷⁶ *Id.*

⁷⁷ The Year that Has Gone, *supra* note 67.

⁷⁸ Tragic Death List Given By Coroners, N.Y. TIMES, Oct. 1, 1911, at 10.

⁷⁹ Auto Fatalities Increase, N.Y. TIMES, Jan. 3, 1920, at 15; Autos Killed 3,808 in America in 1919, N.Y. TIMES, Dec. 6, 1920, at 17 (relating 780 deaths in 1919, drawing from U.S. Census Bureau data). Cf. Violent Deaths Fewer Last Year, N.Y. TIMES, Mar. 24, 1921, at 13 (relating the city Medical Examiner's total calculation of only 692 deaths by automobile in 1920).

⁸⁰ Autos Killed 31,000 in 1929, a 10.2% Rise, N.Y. TIMES, May 25, 1930, at 31.

nation's population was less than half then what it is now, and there were approximately one-tenth the current number of registered vehicles on the road at that time.

Yet the prospect of such a death toll was not on anyone's mind in the late 1890s, when some observers thought automobiles might represent only a fad, as the dwindling bicycle boom had proven to be. When automobiles first appeared, the primary concern of automobilists was that their devices would be flatly barred from the roads.⁸¹ This concern proved unfounded.⁸² Most cities were content to regulate automobiles, instead of banning them.⁸³ One close call came in 1899, when Boston's Board of Aldermen passed an ordinance that would have barred automobiles from city streets unless and until they were expressly endorsed by the aldermen as "not endangering the life or property of others." A cooler head soon prevailed. This measure was vetoed by the mayor, who wrote in his veto message that "it would be much wiser to wait until such developments in this line shall have proceeded further, and it will then be possible to frame a much fuller and wiser regulation than the one now before me."⁸⁴

⁸¹ See *Massachusetts Motor Vehicle Bill*, THE HORSELESS AGE, Mar. 1897, at 1 (paraphrasing the testimony of a manufacturer of automobiles before a Massachusetts legislative committee, to the effect that "people who would otherwise use the carriages are now holding back because they want to see what would be the result of a possible suit on account of damage or accident from the use of the motor vehicles in the streets.").

⁸² In 1899, a leading publication on automobiles observed:

With the exception of New York State, the coast is apparently clear for the motor vehicle throughout the United States. License laws and speed laws are being discussed and will in some instances be enacted, but from the present outlook the motor vehicle will not be burdened with adverse legislation to any great extent, nor for any great length of time.

The Coast is Clear, THE HORSELESS AGE, Aug. 23, 1899, at 6.

⁸³ An early Chicago ordinance, for example, provided that a panel comprised of the city engineer, city electrician, and city health commissioner were to examine all applicants for automobile licenses, and issue licenses to those applicants they regarded as qualified. *Licenses for Automobile Drivers*, KANSAS CITY JOURNAL, Dec. 7, 1899, at 8. A few cities sought to exclude automobiles from public parks, but these modest prohibitions tended to be short-lived. See *Automobile to Displace All Street Cars*, S.F. CALL, July 6, 1899, at 1 (discussing a Chicago judge's decision to strike down a ban on the use of automobiles in a city park, although the judge upheld park commissioners' authority to prescribe speed limits for automobiles within the park); *Automobile Wins the Day*, N.Y. TRIBUNE, Nov. 21, 1899, at 5.

⁸⁴ *Automobiles in Boston*, WASH. TIMES, July 17, 1899, at 6.

As automobiles became increasingly common, state legislatures enacted rudimentary laws regarding their registration, use, and required equipment. By 1906, well over half of the states had enacted statutes concerning at least one of these topics.⁸⁵ Though these laws varied in their terms, common provisions called for the registration of vehicles with the state, prescribed that automobile operators had to be licensed, established maximum speed limits, and required simple safety equipment—frequently brakes, lamps, and a bell, horn, or other signal.⁸⁶ Early speed limits varied significantly from state to state. In 1903, Alabama adopted a statewide speed limit of 8 miles per hour.⁸⁷ At the other extreme, as of 1906 motorists in rural areas of Michigan, Minnesota, and Wisconsin could blaze along at up to 25 miles per hour, if their cars could handle it.⁸⁸ Other states eschewed any specific speed limit, and simply directed motorists to operate their vehicles at a reasonable speed.⁸⁹

Several of these early statutes also instructed motorists on how to behave when they encountered horses on the roads.⁹⁰ Then as now, horses could be easily frightened, leading these animals to injure themselves or others. When such incidents involved a passing motorist, injured persons sometimes sued the automobilist whose vehicle had caused the horse to panic. In fact, in the very first years of American automobile driving, this sort of fact pattern gave rise to most of the tort lawsuits that involved these devices.⁹¹ These lawsuits pressed claims similar to those that horsemen and carriage operators had alleged in the past against bicyclists, railroad operators, and others.⁹²

⁸⁵ XENOPHON P. HUDDY, THE LAW OF AUTOMOBILES 116–325 (1906).

⁸⁶ E.g., An Act to Amend the Highway Law, ch. 531, 1901 N.Y. Laws 83.

⁸⁷ An Act to Regulate Running, Operating or Driving Automobiles, Locomobiles and Motor Vehicles of Like Kind upon the Public Roads and Highways of this State, no. 541, § 4, 1903 Ala. Acts 497, 498.

⁸⁸ An Act to Provide for the Registration and Identification of Motor Vehicles, no. 196, § 12, 1905 Mich. Pub. Acts 287, 290; An Act Regulating Automobiles, Motor Vehicles or Motor Cycles on Public Roads, Highways and Streets within the State of Minnesota, ch. 356, § 1, 1903 Minn. Laws 646, 646; An Act Regulating Automobiles, Auto-Cars and Other Similar Motor Vehicles on the Public Highways Within the State, ch. 305, § 3, 1905 Wis. Sess. Laws 467, 469.

⁸⁹ E.g., An Act Regulating the Running of Automobiles or Motor Vehicles on the Public Roads or Highways in the State of Florida, ch. 5437, § 6, 1905 Fla. Laws 119, 120 (“proper or reasonable” speed).

⁹⁰ E.g., *id.* §§ 8–9.

⁹¹ Some Leading Automobile Suits, THE HORSELESS AGE, Nov. 5, 1902, at 512.

⁹² Kyle Graham, *Of Frightened Horses and Autonomous Vehicles: Tort Law and Its Assimilation of Innovations*, 52 SANTA CLARA L. REV. 1241, 1248–49 (2012).

Fortunately for the defendants, history had shown that while horses often were frightened by new devices on the highways, the animals eventually would become used to their presence; in other words, the frightened-horse problem was anticipated to be only a temporary one. Within the conducive context of these cases, it was resolved fairly quickly that motorists were not strictly liable for injuries associated with their machines, and that automobilists only had to exercise reasonable care in the operation of their vehicles.⁹³ Eventually, of course, frightened-horse lawsuits soon were replaced by a much greater volume of claims involving vehicle crashes and collisions.⁹⁴ When these cases emerged, they were similarly assimilated into the larger body of negligence law that had accumulated in years past, with applicable principles having been developed in cases involving earlier technologies such as carriages and streetcars.⁹⁵

Personal injury lawsuits against automobile manufacturers took longer to appear. A 1906 treatise on automobile law could only speculate on the rules that would apply to an automobile manufacturer in a lawsuit brought by an injured consumer.⁹⁶ Persons injured in early automobile accidents may not have pursued claims against manufacturers because they could not appreciate or identify any negligent behavior by the automaker,⁹⁷ or they may have believed that under prevailing rules, a lack of “privity of contract” between themselves and automobile manufacturers (who by 1906 already had begun to sell their products through intermediaries) would defeat any lawsuit they might pursue. Starting in the 1910s, however, courts significantly pared back or erased the privity requirement in negligence cases brought by the consumers of

⁹³ *Id.* at 1250.

⁹⁴ By 1927, these cases would fill a three-volume treatise more than 2,800 pages in length. DEWITT C. BLASHFIELD, CYCLOPEDIA OF AUTOMOBILE LAW (vol. 1–3, 1927).

⁹⁵ Though not without some regrets. One law professor, writing in 1937, observed,

The automobile has brought upon our roads a new form of transportation. No one can doubt its convenience. ... Nevertheless [its] advantages have been bought at a heavy price in injury or death. Perhaps it would have been for the best had our courts recognized the risk of injury or death both to motorists and to other travelers, which experience has been shown to be inseparable from even careful driving, as sufficient to require of those who use this new means of transportation, the burden of answering for even unavoidable accidents.

Francis H. Bohlen, *Fifty Years of Torts*, 50 HARV. L. REV. 725, 727 (1937).

⁹⁶ HUDDY, *supra* note 85, at 105–06.

⁹⁷ Graham, *supra* note 92, at 1260–62.

mass-marketed products against the manufacturers of these goods, thereby opening their doors to this sort of claim.⁹⁸

As the number of automobiles exploded in the 1920s, so too did the volume of automobile accident litigation. By the late 1920s and early 1930s, tort lawsuits involving automobile accidents constituted 25 percent or more of some urban dockets.⁹⁹ This mass inevitably included some bogus claims. To address the problem of fraud, beginning in the 1920s about half of the states enacted “guest statutes” that barred negligence claims brought against drivers by gratuitous passengers.¹⁰⁰ These laws would remain on the books for decades, although they have since been abolished in every state except Alabama.

The soaring number of automobile accidents and lawsuits also led some observers to have second thoughts about the application of negligence principles and courtroom procedures to these incidents. Proposals emerged to replace the vagaries of litigation with a more mechanical compensation mechanism when automobiles led to injuries. A 1932 Columbia University study of automobile accident litigation determined:

The generally prevailing system of providing damages for motor vehicle accidents is inadequate to meet existing conditions. It is based on the principle of liability for fault which is difficult to apply and often socially undesirable in its application; its administration through the courts is costly and slow, and it makes no provision to ensure the financial responsibility of those who are found to be liable.¹⁰¹

The authors recommended a no-fault compensation plan for injuries associated with automobile accidents, modeled after workers’ compensation programs.¹⁰² Such a concept was several decades ahead of its time, however.¹⁰³ Other efforts to adjust or account for the risks of automobile accidents through legislation also were slow to gain acceptance. While in 1925 Massachusetts became the first state to require drivers to obtain accident insurance as a prerequisite to operating a motor vehicle on the

⁹⁸ See *Olds Motor Works v. Shaffer*, 145 Ky. 616, 623-624, 140 S.W. 1047, 1051 (1911); *MacPherson v. Buick Motor Co.*, 111 N.E. 1050 (N.Y. 1916).

⁹⁹ See COLUMBIA UNIVERSITY COUNCIL FOR RESEARCH IN THE SOCIAL SCIENCES, REPORT BY THE COMMITTEE TO STUDY COMPENSATION FOR AUTOMOBILE ACCIDENTS 20 (1932) (hereinafter “COLUMBIA REPORT”); CHARLES E. CLARK & HARRY SHULMAN, A STUDY OF LAW ADMINISTRATION IN CONNECTICUT 14 (1937).

¹⁰⁰ Stanley W. Widger, Jr., *The Present Status of Automobile Guest Statutes*, 59 CORN. L. REV. 659, 659 (1974).

¹⁰¹ COLUMBIA REPORT, *supra* note 99, at 216-17.

¹⁰² COLUMBIA REPORT, *supra* note 99, at 217.

¹⁰³ For a discussion of the adoption of no-fault insurance schemes, see Nora Freeman Engstrom, *An Alternative Explanation for No-Fault’s “Demise,”* 61 DEPAUL L. REV. 303, 371-79 (2012).

highways,¹⁰⁴ it would take three decades for any other state to follow suit.

The 1920s also saw the federal government collaborate with industry representatives and other groups to address traffic problems through the National Conference on Street and Highway Safety. Chaired by U.S. Secretary of Commerce Herbert Hoover, this body consisted largely of representatives from federal, state, and local governments, business interests, and automobile clubs.¹⁰⁵ The Conference promulgated a Uniform Vehicle Code in 1926.¹⁰⁶ This code sought to standardize disparate state laws on various topics relating to vehicle use. It consisted of four component codes: the Uniform Motor Vehicle Registration Act, the Uniform Motor Vehicle Anti-Theft Act, the Uniform Motor Vehicle Operators’ and Chauffeurs’ License Act, and the Uniform Act Regulating the Operation of Vehicles on the Highways.¹⁰⁷ Portions of the Uniform Vehicle Code soon were adopted by many states,¹⁰⁸ continuing the ongoing process of iterative revision of state automobile laws as these devices grew ever more sophisticated and common. In California, for example, a comprehensive 1905 statute concerning automobiles gave way to another in 1919, and to yet another in 1923.¹⁰⁹

With the soaring number of automobiles came recognition of new forms of antisocial behavior, among them automobile theft,¹¹⁰ hit-and-run incidents,¹¹¹ and driving while intoxicated.¹¹² States started to recognize these offenses as warranting distinct recognition and treatment not long after the first wave of automobile statutes appeared. Early criminal laws prohibiting driving while intoxicated described the unlawful conduct in general terms, such as a 1910 New York statute that forbade “operating a motor vehicle while in an intoxicated

¹⁰⁴ Act of May 1, 1925, ch. 346, § 2, 1925 Mass. Acts 426, 426-31.

¹⁰⁵ NATIONAL CONFERENCE ON STREET AND HIGHWAY SAFETY, UNIFORM VEHICLE CODE i–iii (1926). The National Conference of Commissioners on Uniform State Laws assisted with this project.

¹⁰⁶ *Id.*

¹⁰⁷ *Id.* at 3-106.

¹⁰⁸ PETER D. NORTON, FIGHTING TRAFFIC: THE DAWN OF THE MOTOR AGE IN THE AMERICAN CITY 193 (2011).

¹⁰⁹ J. Allen Davis, *The California Vehicle Code and the Uniform Vehicle Code*, 14 HASTINGS L.J. 377, 377 (1963).

¹¹⁰ An Act to Prohibit the Unauthorized Taking or Using of Automobiles or Other Motor Vehicles, no. 33, § 1, 1909 Mich. Pub. Acts 54, 54.

¹¹¹ Act of May 31, 1910, ch. 374, § 1, N.Y. Laws 673, 684.

¹¹² An Act Defining Motor Vehicles and Providing for the Registration of Same, ch. 113, § 19, 1906 N.J. Laws, 177, 186; Act of April 4, 1907, ch. 144, § 7, 1907 Del. Laws 264, 267.

condition.”¹¹³ These laws were refined after a series of studies in the 1930s clarified the correlation between impairment and blood alcohol concentrations.¹¹⁴ In New York, a 1941 law declared that when a breath, blood, urine, or saliva test established that a person had a blood alcohol concentration of .15 percent or higher within 2 hours after their arrest for driving while intoxicated, this result would constitute *prima facie* evidence at trial that the tested individual had been driving in violation of state law.¹¹⁵

This modification of the crime of driving while intoxicated came near the close of an era in which most injuries associated with automobile accidents were blamed on human error.¹¹⁶ In the 1950s and especially the 1960s, attention turned to how automakers might design their motor vehicles to reduce occupant injuries in the event of an accident.¹¹⁷ In 1966, Congress inaugurated the modern era of federal regulation of vehicle design by passing the National Traffic and Motor Vehicle Safety Act of 1966¹¹⁸ and the Highway Safety Act of 1966.¹¹⁹ The first of these statutes authorized the promulgation of federal motor vehicle safety standards,¹²⁰ while the latter created the National Highway Safety Agency to implement the provisions of both its authorizing statute and the National Traffic and Motor Vehicle Safety Act.¹²¹ Four years later, Title II of the Highway Safety Act of 1970¹²² established the National Highway Traffic Safety Administration and conferred upon it the authority previously allocated to the National Highway Safety Agency.¹²³ At

¹¹³ Act of May 31, 1910, ch. 374, § 1, N.Y. Laws 673, 684.

¹¹⁴ See BARRON H. LERNER, ONE FOR THE ROAD: DRUNK DRIVING SINCE 1900, at 24–31 (2011).

¹¹⁵ An Act to Amend the Vehicle and Traffic Law, ch. 726, § 1, 1941 N.Y. Laws 1623, 1623.

¹¹⁶ For discussions of the various efforts by policymakers to address this problem, see DAVID BLANKE, HELL ON WHEELS: THE PROMISE AND PERIL OF AMERICA’S CAR CULTURE, 1900–1940 (2007).

¹¹⁷ See RALPH NADER, UNSAFE AT ANY SPEED: THE DESIGNED-IN DANGERS OF THE AMERICAN AUTOMOBILE (1965); Daniel P. Moynihan, *Epidemic on the Highways*, THE REPORTER, Apr. 30, 1959, at 16; C. Hunter Shelden, *Prevention, the Only Cure for Head Injuries Resulting from Automobile Accidents*, 159 J. AM. MED. ASS’N 981 (1955); *Death on the Highways*, 163 J. AM. MED. ASS’N 262 (Jan. 1957).

¹¹⁸ National Traffic and Motor Vehicle Safety Act of 1966, Pub. L. No. 89-563, 80 Stat. 718.

¹¹⁹ Highway Safety Act of 1966, Pub. L. No. 89-564, 80 Stat. 731.

¹²⁰ National Traffic and Motor Vehicle Safety Act of 1966, § 103(a).

¹²¹ *Id.*, § 201.

¹²² Highway Safety Act of 1970, Pub. L. No. 91-605, 84 Stat. 1713.

¹²³ *Id.*, § 202.

around the same time, manufacturers’ design decisions also came under closer scrutiny in the courts. Beginning in the mid-1960s, almost all states recognized that these companies could be held strictly liable in tort to consumers when their unreasonably unsafe product designs led to injuries—a concept that will receive more attention later in this report.¹²⁴

F. Airplanes

The litigants and judges in early automobile lawsuits benefited from a large body of case law that addressed other highway mishaps, similar except for the technologies involved. With early airplanes and the relative novelty of flight, much less pertinent law existed to help people understand how these devices fit within prevailing doctrine.

Strange as it may seem today, the primary safety concern associated with early airflight did not involve harm to passengers, but danger to those on the ground.¹²⁵ The few early passengers were regarded as taking their chances by venturing into the air. Early airplanes were relatively slow and had a short travel radius, making them a generally undesirable transportation option for all but short-distance routes over water.¹²⁶ Furthermore, airplanes and their pilots had a terrible safety reputation among the general public.¹²⁷ One booster wrote in 1911 that “many otherwise well-informed persons have come to view aeronautical progress as the development of a most desperate and dangerous folly, and to see in every aviator a money-mad participant in a carnival of death, and in every flying ground a shambles.”¹²⁸ This perception persisted well into the 1920s, and it (as well as the judgment-proof nature of many early

¹²⁴ See Kyle Graham, *Strict Products Liability at 50: Four Histories*, 98 MARQ. L. REV. 555, 576–79 (2014) (discussing the adoption of strict products liability in tort).

¹²⁵ Another broadly appreciated concern associated with early airplanes involved how use of these devices could be reconciled with the longstanding rule that persons who own land also owned air rights up into the stratosphere. See generally STUART BANNER, WHO OWNS THE SKY? THE STRUGGLE TO CONTROL AIRSPACE FROM THE WRIGHT BROTHERS ON (2008) (discussing this concern and the efforts that were taken to address it).

¹²⁶ See Graham, *supra* note 92, at 1262, n.89 (discussing the limited capabilities of early airplanes as means of long-distance travel).

¹²⁷ See, e.g., Arthur West, *How Safe Is an Airplane?*, MUNSEY’S MAG., Apr. 1920, at 435; Burtoni J. Hendrick, *The Safe and Useful Airplane*, An Interview with Orville, AVIATION AND AERONAUTICAL ENG., Apr. 1, 1917, at 224 (quoting Orville Wright as saying “the average citizen is still frightened at the prospect of leaving the ground and having no support except the air itself.”).

¹²⁸ Victor Lougheed, *The Fatalities of Flight*, POPULAR MECHANICS, July 1911, at 9.

fliers¹²⁹) had a chilling effect on the pursuit of tort claims against air service providers.¹³⁰ Claims for injury or death against airplane manufacturers for negligence took even longer to appear,¹³¹ for reasons including the complexity of aircraft design, difficulties in piecing together the causes of an accident, and a general tendency to blame early mishaps on pilot error.¹³²

But people on the ground had not assumed any risks associated with flying. To this broader segment of the public, the principal worry was that a plane might crash onto them as they went about their earth-bound business.¹³³ For this scenario, there was a case on point—if only one, and an old one at that. In *Guille v. Swan*,¹³⁴ decided in 1822, the defendant, a hot air balloonist, had crashed his balloon in the plaintiff's yard. The court held that the defendant was strictly liable for damage associated with his landing.¹³⁵

This single case provided a slender basis for the imposition of strict liability for ground damage when airplanes crashed, a century later. Nevertheless, the analogy proved compelling to those early commentators who regarded even motorized airflight as an ultrahazardous activity of little social utility.¹³⁶ As airplane technology advanced, these devices proved their usefulness, and a larger proportion of the public took advantage of these benefits, the law slowly drifted away from its strict-liability stance. The modern trend is to apply negligence law, as opposed to strict liability, to determine liability for ground

¹²⁹ Two states—Massachusetts and Connecticut—enacted statutes in the early 1910s that, in addition to prescribing licensing and registration requirements for aircraft, made aviators liable in the event of accidents. An Act Concerning the Registration, Numbering, and Use of Air Ships, and the Licensing of Operators Thereof, ch. 86, § 11, 1911 Conn. Acts 1348, 1351 (“Every aeronaut shall be responsible for all damages suffered in this state by any person from injuries caused by any voyage in an air ship directed by such aeronaut.”); An Act to Regulate the Use of Air Craft, ch. 663, § 6, 1913 Mass. Acts 609, 611 (providing that an aviator “shall be held liable for injuries resulting from his flying unless he can demonstrate that he had taken every reasonable precaution to prevent such injury”).

¹³⁰ See Graham, *supra* note 92, at 1262–65.

¹³¹ See STUART M. SPEISER, LAWSUIT 164 (1980) (discussing this dearth of claims).

¹³² See THE TRAVELERS INSURANCE COMPANY, AIRPLANES AND SAFETY 43 (1921) (discussing the perceived causes of airplane crashes).

¹³³ See, e.g., HAROLD D. HAZELTINE, THE LAW OF THE AIR 81–82 (1910) (discussing this scenario); Denys P. Myers, *Law and the Air: Neutrals and the Air*, AIRCRAFT, Oct. 1, 1910, at 8.

¹³⁴ 19 Johns. 381 (N.Y. Sup. Ct. 1822).

¹³⁵ *Id.* at 383.

¹³⁶ Wayne C. Williams, *The Law of the Air*, OUTLOOK, Sept. 22, 1920, at 145.

damage associated with aircraft.¹³⁷ But the earlier strict-liability approach has proven fairly “sticky,” and remains in favor among some audiences.¹³⁸

The federal government became involved in airline safety regulation in 1926, with the enactment of the Air Commerce Act.¹³⁹ This statute owed its existence to the endorsement of early commercial airline operators, who desired enhanced government safety regulation in order to assure the public that air travel was not as unsafe as the litany of accidents involving barnstormers might have suggested.¹⁴⁰ The statute delegated upon the Secretary of Commerce responsibility for registering and rating the airworthiness of aircraft,¹⁴¹ examining airmen for competence,¹⁴² and establishing air traffic rules.¹⁴³ The law also directed the Secretary to “investigate, record, and make public the causes of accidents in civil air navigation in the United States.”¹⁴⁴ Three decades later, the collision of two passenger aircraft over the Grand Canyon would contribute to the creation of the Federal Aviation Agency (now the Federal Aviation Administration), or FAA, the federal agency tasked today with principal responsibility for ensuring airline safety.¹⁴⁵

G. Computers

For the most part, computers have not yet been closely connected to physical harm or property damage, and therefore have not led to much regulation or courtroom practice designed to ward off or seek redress for these injuries.¹⁴⁶ Instead, a more keenly

¹³⁷ E.g., *Crosby v. Cox Aircraft Co. of Washington*, 109 Wash. 2d 581, 588, 746 P.2d 1198, 1202 (Wash. 1987).

¹³⁸ See RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL AND EMOTIONAL HARM § 20, Am. Law Inst. (2010) (discussing this split of opinion).

¹³⁹ An Act to Encourage and Regulate the Use of Aircraft in Commerce, and for Other Purposes, Pub. L. No. 69-254, ch. 344, 44 Stat. 568 (1926).

¹⁴⁰ See *The Demand for Air Laws*, SCIENTIFIC AMERICAN, Aug. 1923, at 84 (discussing the broad backing for such legislation).

¹⁴¹ An Act to Encourage and Regulate the Use of Air Commerce Act § 3(a), (b).

¹⁴² *Id.* § 3(c).

¹⁴³ *Id.* § 3(e).

¹⁴⁴ *Id.* §2(e).

¹⁴⁵ ROGER E. BILSTEIN, FLIGHT IN AMERICA 232 (3d ed. 2001).

¹⁴⁶ See Laurel M. Cohn, *Products Liability: Computer Hardware and Software*, 59 A.L.R. 461 (1998) (aggregating products liability cases that involved alleged computer defects); Intel Corp. v. Hamidi, 30 Cal. 4th 1342, 1347 (2003) (holding that no actionable claim for trespass to chattels exists when “spam” email “neither damages the recipient computer system nor impairs its functioning”). The federal and many state governments have assigned civil liability for certain types of unwelcome behavior involving computers, with one example being the “anti-spam” laws designed to control the flow of unwanted commercial email messages. SUSAN W. BRENNER, 1 DATA SECURITY AND PRIVACY LAW § 7.68 (2015) & *id.* at vol. 2, § 15.20.

appreciated hazard associated with computers and computer systems has involved the exploitation of data by insiders or “hackers.”¹⁴⁷ Concerns regarding this type of misbehavior have led governments to enact computer-crime laws designed to deter unauthorized access and other forms of computer abuse.

Prior to the late-1970s, most misconduct involving computers consisted of fraud or embezzlement schemes that somehow made use of these devices to plunder a bank or another business.¹⁴⁸ These crimes generally were addressed within the existing rubric of fraud, theft, and conspiracy laws. As years passed and computers grew more widespread and powerful, more complicated schemes appeared. One such scam involved the manipulation of pari-mutuel betting at the Flagler Dog Track in Florida by employees during the mid-1970s.¹⁴⁹

This case led to Florida’s enactment of the country’s first computer-crimes statute in 1978.¹⁵⁰ The Florida legislature found that “[w]hile various forms of computer crime might possibly be the subject of criminal charges based on other provisions of law, it is appropriate and desirable that a supplemental and additional statute be provided which proscribes various forms of computer abuse.”¹⁵¹ The Florida law recognized several new crimes specific to computers. Its provisions prohibited such conduct as tampering with or destroying computer data, the disclosure or unauthorized acquisition of trade secrets or other confidential data found on computers, gaining unauthorized access to a computer or a computer system or network, and willfully and knowingly causing these devices to crash or otherwise deny service to users.¹⁵²

In other states, without any similarly notorious scheme to catalyze legislative action, the array of computer crimes accumulated in a more incremental manner. California’s first take on the subject in

¹⁴⁷ In the late 1960s and early 1970s, computers were often the objects (as opposed to the instruments) of criminal behavior. Computer labs were occupied, vandalized, and in some cases destroyed during this era of student protests. David P. Julyk, *The Trouble with Machines Is People: The Computer as Icon in Post-War America: 1946–1970*, at 214–15 (unpublished University of Michigan Ph.D. dissertation, 2008).

¹⁴⁸ See DONN B. PARKER, *CRIME BY COMPUTER* (1976) (collection of these cases); John K. Taber, *On Computer Crime (Senate Bill S. 240)*, 1 COMPUTER L.J. 517, 517, 526 (1979) (discussing and critiquing then-circulating estimates regarding the number of computer crimes that had been committed).

¹⁴⁹ Marilyn Hochman, *The Flagler Dog Track Case*, 7 COMP. L.J. 117, 117–24 (1986).

¹⁵⁰ *Id.* at 125.

¹⁵¹ Florida Computer Crimes Act, ch. 78-92, § 1, 1978 Fla. Stat. 815.02 (5) (2015).

¹⁵² *Id.* at 141–42.

1979¹⁵³ prohibited accessing a computer system or network as part of a scheme to defraud, or to obtain money, property, or services with fraudulent intent.¹⁵⁴ This law further specified that “[a]ny person who maliciously accesses, alters, deletes, damages, or destroys any computer system, computer network, computer program, or data shall be guilty of a public offense.”¹⁵⁵

Additional crimes were added later, as new fears appeared regarding computer misuse. In 1981, the California legislature added two new crimes, both dealing with the use of computers to store credit information.¹⁵⁶ One of the new offenses prohibited the malicious acquisition of credit information stored on computers.¹⁵⁷ The other forbade the wrongful manipulation of credit information stored on computers.¹⁵⁸ A report to the California governor advised that these crimes were intended to address “a problem that is likely to become more prevalent with the advent of automated banking, purchasing and credit information being computerized.”¹⁵⁹ Three years later, in response to concerns about computer “hackers” who acquired access to computer systems for fun rather than profit, the legislature criminalized the intentional acquisition of unauthorized access to a computer system.¹⁶⁰ Finally, in 1987, the legislature enacted a new statute developed by a committee consisting of representatives from law enforcement agencies and private businesses.¹⁶¹ This statute criminalized an array of conduct, going beyond that addressed by earlier prohibitions. Several of these provisions required less pronounced criminal intent than that necessary for commission of previously recognized computer crimes. One new provision made it a crime when an individual “[k]nowingly and without permission uses or causes to be used computer services.”¹⁶²

¹⁵³ A proposal for federal computer-crime legislation was introduced in Congress in 1977. Federal Computer Systems Protection Act, S. 1766, 95th Cong. (1977). Congress did not pass this bill, however, and the first federal computer-crime measure became law only in 1984. Comprehensive Crime Control Act of 1984, Pub. L. No. 98-473, § 2102(a), 98 Stat. 1976, 2190.

¹⁵⁴ Act of Sept. 21, 1979, ch. 858, § 1, 1979 Cal. Stats. 2968, 2968.

¹⁵⁵ *Id.* § 1, at 2969.

¹⁵⁶ Act of Sept. 26, 1981, ch. 837, 1981 Cal. Stats. 3224.

¹⁵⁷ *Id.* § 1, at 3225.

¹⁵⁸ *Id.*

¹⁵⁹ Lester Jones, Enrolled Bill Memorandum to Governor, Sept. 23, 1981, at 3.

¹⁶⁰ Act of Sept. 7, 1984, ch. 949, § 2, 1984 Cal. Stats. 3296, 3297–98.

¹⁶¹ Comprehensive Computer Data Access and Fraud Act, ch. 1499, 1987 Cal. Stats. 5782.

¹⁶² *Id.* § 3, at 5784.

Other new crimes addressed situations where a person “[k]nowingly accesses and without permission takes, copies, or makes use of any data from a computer, computer system, or computer network,”¹⁶³ or “[k]nowingly accesses and without permission adds, alters, damages, deletes, or destroys any data, computer software, or computer programs which reside or exist internal or external to a computer, computer system, or computer network.”¹⁶⁴

While criminal liability for the misuse of computers and computer networks has grown, civil liability for misbehavior on the Internet has been stunted by the enactment of Section 230 of the Communications Decency Act of 1996.¹⁶⁵ This provision was adopted in response to two early cases involving defamation claims brought against online service providers. In the first of these matters, decided in 1991, a federal district court held out the prospect of liability if an online service provider “knew or had reason to know of the allegedly defamatory . . . statements” posted by others on its online bulletin boards.¹⁶⁶ In the second, a lower New York state court held in 1995 that an online service provider who held itself out as exercising editorial control over information posted by others on its online bulletin boards, and in fact exercised this control, would be regarded as a “publisher” of that information for purposes of assigning liability for defamation.¹⁶⁷

Section 230 responded to concerns that these rulings, and any similar decisions in the future, would deter online service providers from screening offensive material posted by third parties to bulletin boards and other Internet forums under their control, for fear of being treated as the “publisher” of whatever information remained.¹⁶⁸ Section 230 therefore rules out the prospect that such actions will convert a service provider into a publisher, providing that “[n]o provider or user of an interactive computer service shall be treated as the publisher or speaker of any information provided by another information content provider.”¹⁶⁹ Congress saw this grant of immunity as consistent with general policies “to promote the continued development of the

¹⁶³ *Id.*

¹⁶⁴ *Id.*

¹⁶⁵ The Communications Decency Act of 1996, Pub. L. No. 104-104, § 509, 110 Stat. 133, 137–39 (Title V of the Telecommunications Act of 1996).

¹⁶⁶ *Cubby, Inc. v. CompuServe Inc.*, 776 F. Supp. 135, 141 (S.D.N.Y. 1991).

¹⁶⁷ *Stratton Oakmont, Inc. v. Prodigy Servs. Co.*, 1995 N.Y. Misc. LEXIS 229, at *4 (BNA) (N.Y. Sup. Ct. May 24, 1995).

¹⁶⁸ *Zeran v. America Online, Inc.*, 129 F.3d 327, 331 (4th Cir. 1997).

¹⁶⁹ 47 U.S.C. § 230(c)(1) (2012).

Internet and other interactive computer services and other interactive media”¹⁷⁰ and “to preserve the vibrant and competitive free market that presently exists for the Internet and other interactive computer services, unfettered by Federal or State regulation.”¹⁷¹

Consistent with Congress’s avowed policies, courts have adopted a broad construction of the immunity from civil claims conferred by Section 230. Online services have evolved from a small number of simple bulletin boards and other rudimentary sites to the roughly 1 billion Internet websites now estimated to exist, and use of email services has become commonplace. In this expanding online universe, Section 230 routinely dooms common-law tort theories alleged against website operators for content posted by third parties. Courts also have applied Section 230 to persons who forwarded allegedly defamatory e-mail messages,¹⁷² although one court has noted the “disturbing implications” of conferring immunity upon “users” of “interactive computer services” who intentionally republish defamatory information acquired from another “information content provider.”¹⁷³

H. Conclusions

This overview, though brief, indicates how new technologies can present recurring challenges to the existing legal order. The responses generated by policymakers, meanwhile, offer some insights into how these challenges have been perceived and addressed.

First, new technologies can prompt a variety of policy responses, differing along dimensions that include their timing and the branch and level of government responsible for them. The perceived dangers of some innovations, or desires to capture their benefits, have led to almost immediate policy feedback. Section 230 of the Communications Decency Act provides a recent example of such a measure enacted early in a technology’s lifespan. With other technologies, such as airplanes, it has taken longer for risk to translate into active policy. The levels and branches of government given primary responsibility for the creation of policy also have varied from technology to technology. States and localities have taken the lead in the creation of policies pertinent to some devices; the federal government has assumed

¹⁷⁰ *Id.* § 230(b)(1).

¹⁷¹ *Id.* § 230(b)(2). Section 230 expressly excludes federal criminal law from its scope and does not prohibit “any State from enforcing any State law that is consistent” with its terms. 47 U.S.C. § 230(e)(1), (3).

¹⁷² E.g., *Mitan v. A. Neumann & Assocs., LLC*, Case No. Civ. 08-6154, 2010 U.S. Dist. LEXIS 121568 (D. N.J. Nov. 17, 2010).

¹⁷³ *Barrett v. Rosenthal*, 40 Cal. 4th 33, 62, 146 P. 3d 510, 528 (2006).

this role with other technologies. With some innovations, risks were addressed primarily through the judiciary and damages actions; with others, through criminal laws and other statutes.

Second, the policy responses to new technologies often evolve over time. Early efforts to address the risks associated with innovations are subject to review and revision as the technologies evolve, expectations shift, and initial efforts at risk regulation prove inadequate or ill-fitting to changed conditions. The first federal law aimed at solving the bursting-boiler problem failed to meet its goal, but a second attempt, which learned from the earlier failure, succeeded. Speed limits for automobiles represent another example of a safety rule that has required periodic reevaluation. In many instances, new or successive policy efforts have capitalized upon a growing knowledge base regarding a technology and the risks it presents. The evolution of driving while intoxicated laws for motorists shows this dynamic at work, as does the emergence of more sophisticated safety standards for steamboat boilers.

Third, these policy responses commonly track changing attitudes regarding the perceived benefits and drawbacks of a technology. The preceding text, for example, establishes that certain types of risk tend to be appreciated more keenly and quickly than others are. “Unassumed” risks, incurred by those who do not directly partake of a technology’s benefits, tend to be overemphasized relative to their likelihood of occurrence, while injuries by those who somehow have accepted and benefited from the dangers of a new technology tend to be downplayed, at least at first. Hence the early focus on the dangers of airplanes to those still upon the ground, and the belated attention paid to the hazards encountered by air passengers. Similarly, cumulative risks that eventually follow from broad adoption of a technology may be difficult to anticipate early in the diffusion process, while the innovation is still gaining an initial foothold among consumers. It also can take time and the refinement of an innovation to isolate its *avoidable* risks, as opposed to those dangers forever inherent in a product or service.

Fourth, discrete and unpredictable incidents can play instrumental roles in catalyzing policy, at least when these episodes are sufficiently notorious and occur at opportune times. The enactment of technology-regulating laws after the Moselle disaster and the Flagler racetrack heist represent merely two of many examples of this phenomenon in action.

Fifth, notwithstanding the iterative nature of policymaking, within any particular forum early measures may have a long-term impact on the

development of the law applicable to a technology. Once again, Section 230 provides a useful example of this phenomenon, as do early computer-crimes statutes. Unless and until a crisis occurs, legislators may prefer not to revisit issues that were “resolved” at an early stage of a technology’s development. This disinterest may lead to the continued application of statutes adopted with only embryonic forms of a technology in mind. This tendency toward inertia also can appear within the judiciary, where the doctrine of *stare decisis* imposes a form of path dependence on the law.¹⁷⁴

Sixth, policymakers rely upon processes of analogy in perceiving and addressing the pros and cons of a new technology, and often view an innovation in light of the comparable qualities of substitute technologies. When an innovation resembles a technology already in common use in its form and function, rules already applied to the older technology frequently are extended to the more novel system or device.¹⁷⁵ Sometimes these old rules fit well, sometimes they do not. The absence of ready analogies has meant that truly novel innovations, such as airplanes, have tended to avoid complex regulation, at least for a time.¹⁷⁶ This delay has not always owed to a lack of perceived risk. Rather, this lag often has followed from difficulties that plaintiffs and policy advocates have had describing this risk in terms conducive to regulation, and to the understandable hesitation that policymakers sometimes have about engaging in potentially premature regulation of transformational technologies.

Seventh, and finally, specific innovations may produce changes in the law that ultimately sweep more broadly than initially anticipated. Congress’s engagement with boiler safety set the stage for future federal engagement in other regulatory contexts.¹⁷⁷ Tort lawsuits involving railroads facilitated the maturation of negligence doctrine and led to the development of the “attractive nuisance” principle, a rule now generally applicable to landowners.

¹⁷⁴ See Oona A. Hathaway, *Path Dependence in the Law: The Course and Pattern of Legal Change in a Common Law System*, 86 IOWA L. REV. 601 (2001).

¹⁷⁵ See Gregory N. Mandel, *Lessons for a General Theory of Law and Technology*, 8 MINN. J.L. SCI. & TECH. 551, 553–57 (2007) (making a similar point).

¹⁷⁶ Gary E. Marchant, *The Growing Gap Between Emerging Technologies and the Law*, in *THE GROWING GAP BETWEEN EMERGING TECHNOLOGIES AND LEGAL-ETHICAL OVERSIGHT* 19–33 (Gary E. Marchant, Joseph R. Heckert & Braden R. Allenby eds., 2011).

¹⁷⁷ See Jerry L. Mashaw, *Administration and “The Democracy”: Administrative Law from Jackson to Lincoln, 1829–1861*, 117 YALE L.J. 1568 (2008) (placing the boiler statutes in historical context).

Whether similar echoes follow from the policies adopted toward more recent technologies, such as computers, remains to be seen.

What do these principles mean for the legal environment for driverless vehicles? Above all else, they point toward an evolving policy response to these devices. Policymaking probably will begin with rudimentary measures and become more complex and far-reaching over time. At first, the aspects of driverless vehicles regarded as most suitable for regulation will be defined largely, if not entirely, by reference to the law that surrounds conventional vehicles. But as driverless vehicles grow increasingly sophisticated and common, more and more novel issues will arise that will require innovative and thoughtful responses from policymakers. Some of these policies eventually may produce far-reaching changes in the ambient law.

At the same time, past experience also suggests that the policymaking path for new technologies can be unpredictable. As earlier episodes establish, a single incident may cause lawmakers to step in to address the perceived risks associated with a novel technology. Therefore, forecasts regarding the “likely” or “optimal” policy responses to driverless vehicles should be ventured with caution, and with an appreciation that alternative approaches may prevail.

With that, this report will conclude its discussion of other, past technologies and proceed to the characteristics and potential uses of driverless vehicles.

III. Characteristics and Technologies of Driverless Vehicles

Driverless vehicles are motor vehicles in which internal vehicle systems, instead of a human driver, operate all functions as the vehicle moves on public roadways. They can take the form of passenger cars, large or small trucks, buses, or other modes of motorized ground transportation. They may transport either cargo or human passengers, or both, or neither.

Varied terminology regarding motor vehicles without human drivers complicates policymaking about driverless vehicles. These vehicles are sometimes referred to as “entirely self-driving,” as “fully autonomous,” or even as “completely automated,” in addition to being more aptly called “driverless vehicles.”¹⁷⁸ The negative attribute of being driverless

¹⁷⁸ Early in the 20th century, “driverless automobiles” referred to a regulated business now known as the rental car business. Instead of hiring a motor vehicle with a driver, a person could rent a “Driverless Car” from a “business of renting and hiring automobiles and motor vehicles without a driver.” *Driverless Car Co. v. Glessner-Thornberry Driverless Car Co.*, 83 Colo. 262, 264, 264 P. 653, 654 (1928). In this trademark infringement case, the Supreme Court of

echoes the “horseless carriages” name for human-driven automobiles over a hundred years ago. Both phrases suggest a comfortable transformation from something familiar into something new that is, in fact, transformative.

Some of the same technologies used in driverless vehicles provide automated features in conventional vehicles. But automated vehicles are not necessarily driverless. Already available automated, semi-autonomous, or self-driving technologies assist human drivers who control all or some of the vehicles’ operations. Familiar automated technologies currently assist drivers with specific vehicle functions, such as braking or parking, but continue to need a human driver to control general vehicle operations. Moreover, international conventions¹⁷⁹ and state laws expressly require a driver to be in control of a motor vehicle operating on public roads.¹⁸⁰

Currently available varieties of automated, self-driving, semi-autonomous, or connected features on conventional vehicles will provide experience with the application of some of the types of technologies that are also applied in driverless vehicles. On-road

Colorado held that “driverless,” as applied to cars, was even then generic and therefore did not infringe any trademark. *Id.* at 270. Many of the earliest driverless car cases come from Texas, where in 1918 the City of San Antonio adopted “An ordinance for the licensing and regulation of driverless automobiles, hired or leased to the public for use on or over the streets or thoroughfares of the city of San Antonio.” *City of San Antonio v. Besteiro*, 209 S.W. 472, 472 (Tex. Ct. Civ. App. 1919), upheld this ordinance, which required registration and financial responsibility. *Id.* at 473–74. Other state courts, as well as the United States Supreme Court, similarly upheld driverless-car regulations. *E.g.*, *Hodge Drive-It-Yourself Co v. City of Cincinnati*, 284 U.S. 335, 52 S. Ct. 144, 76 L. Ed. 323 (1932).

¹⁷⁹ Convention on Road Traffic, Geneva, Sept. 19, 1949, 3 U.S.T. 3008, 125 U.N.T.S. 3 and Vienna Convention on the Law of Treaties, art. 31, May 23, 1969, 1155 U.N.T.S. 331, 8 I.L.M. 679. Article 8, Sections 1 and 5 of the Vienna Convention require that “[e]very moving vehicle or combination of vehicles shall have a [person] driver,” and “[e]very driver shall at all times be able to control his vehicle.” Section 1 of Article 13 further requires, “Every driver of a vehicle shall in all circumstances have his vehicle under control so as to be able to exercise due and proper care and to be at all times in a position to perform all manoeuvres required of him.”

¹⁸⁰ Laws in some states that govern driverless or runaway vehicles impose liability on the owner of a driverless vehicle that causes damage or injury. *E.g.*, CAL VEH. CODE § 16001 (2015). Most states have laws that require a licensed driver be in control of motor vehicles. *Self-Driving Cars and Insurance*, INS. INFO. INST. (Feb. 2015), <http://www.iii.org/issue-update/self-driving-cars-and-insurance>. Still, vehicle automation that assists drivers is generally legal in the United States. Bryant Walker Smith, *Automated Vehicles Are Probably Legal in the United States*, 1 TEX. A&M L. REV. 411 (2014).

performance of these limited self-driving features, or autonomous operational modes, or automated operations will contribute data to inform legal policy decisions about vehicles that operate entirely without human drivers. Still, legal and policy issues posed by driverless vehicles operating without human drivers are very different from issues posed by vehicles that have not entirely obviated a human operator.

A. Distinctive Characteristics of Driverless Vehicles

Driverless vehicles offer a means of roadway transportation for both goods and people that operates and controls its own operations and movements. Driverless vehicles are expected to be safer, more efficient, and more environmentally benign than conventional driver-operated vehicles.¹⁸¹ They are expected to save thousands of lives and millions of dollars in avoided damage and waste. Existing motor vehicle regulatory requirements (such as extensive passive safety equipment, pollution control devices, and the like) may cause the earliest driverless vehicles outwardly to appear similar to conventional vehicles. Ultimately, driverless vehicles will probably look quite different from human-driven vehicles. Driverless vehicles' crash-avoidance capabilities should obviate the need for robust passive safety features, such as heavy materials, bumpers, air bags, or even full-visibility windshields. However, before such physical changes can occur, a great deal of legal and regulatory change will need to take place.

1. Autonomous, Automated, and Self-Driving Features

Various applications of automated vehicle systems—from electronic stability control to automatic lane keeping, parking, and braking systems—enable vehicles to perform specific tasks without human intervention. Recently introduced automated systems that control some or all vehicle operations for part of a journey or in a specific roadway environment are also available. However, for now, human drivers remain in overall control, particularly in emergencies. General Motors' "Super Cruise"¹⁸² and Tesla's promised "Autopilot"¹⁸³ are brand-associated

¹⁸¹ See JAMES M. ANDERSON ET AL., AUTONOMOUS VEHICLE TECHNOLOGY: A GUIDE FOR POLICYMAKERS 2 (2014), http://www.rand.org/content/dam/rand/pubs/research_reports/RR400/RR443-1/RAND_RR443-1.pdf (hereinafter "RAND REPORT"), at 9–40.

¹⁸² Jerry Hirsch, *GM will introduce hands-free, foot-free driving in 2017 Cadillac*, L.A. TIMES (Sept. 7, 2014), <http://www.latimes.com/business/autos/la-fi-hy-gm-cadillac-super-cruise-20140907-story.html>.

¹⁸³ 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/>.

features advertised as making vehicles autonomous or self-driving. However, even such highly automated vehicle functions and self-driving modes do not enable cars having such automated features to be driverless, in the sense of dispensing entirely with a human driver. A human driver remains both legally and practically required to be present and capable of positive operational control of these vehicles. In contrast, driverless vehicles operate without any human control and therefore pose legal and policy issues different from those posed by vehicles that continue to rely on the presence of a human driver.

2. Levels of Automation

For many advanced automotive system developers, "autonomous" became sufficiently ambiguous that standard-setting and regulatory bodies avoid using it in favor of "a range of vehicle automation." Increasing degrees of vehicle automation, in an inverse relationship with human control, seems helpful in describing the increasingly sophisticated stages of vehicle automation technologies.

In fact, there are two separate versions of vehicle automation levels. For both of them, driverless vehicles are at the highest level of full automation, meaning that the vehicle is in complete control of all driving functions at all times. In 2013, the National Highway Traffic Safety Administration (NHTSA) suggested vehicle automation levels in the agency's "Preliminary Statement of Policy Concerning Automated Vehicles."¹⁸⁴ In January 2014, Society of Automotive Engineers (SAE) International suggested a slightly different "Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems" as SAE Standard J3016.¹⁸⁵

The two competing sets of categories, or levels, are:

SAE Automation Levels

- 0—No Automation
- 1—Driver Assistance
- 2—Partial Automation
- 3—Conditional Automation
- 4—High Automation
- 5—Full Automation [Driverless]

NHTSA Automation Levels

- Level 0—No Automation
- Level 1—Function-specific Automation

¹⁸⁴ NAT'L HIGHWAY TRAFFIC ADMIN., U.S. DEP'T OF TRANSP., PRELIMINARY STATEMENT OF POLICY CONCERNING AUTOMATED VEHICLES (2013) (hereinafter "NHTSA PRELIMINARY STATEMENT"), http://www.nhtsa.gov/staticfiles/rulemaking/pdf/Automated_Vehicles_Policy.pdf.

¹⁸⁵ SAE International, *Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems*, SAE International Standard J3016, issued 2014-01-16. Summary table available at http://www.sae.org/misc/pdfs/automated_driving.pdf.

- Level 2—Combined Function Automation
- Level 3—Limited Self-Driving Automation
- Level 4—Full Self-Driving Automation [Driverless]

It is noteworthy that driverless vehicles occupy the highest level of automation in both systems.¹⁸⁶ Under NHTSA categories, currently available vehicle automation technologies are at level 2, and are rapidly moving into level 3, but are not yet close to the driverless top NHTSA automation level 4—completely driverless operation. Similarly, existing vehicle automation is currently between SAE levels 2 and 3.

Federal and state regulators in the United States generally refer to NHTSA vehicle automation levels. Vehicle manufacturers often use the SAE categories, which are similar to vehicle automation categories used in Europe. This report uses the NHTSA levels of vehicle automation as reference points.

3. Consumer Acceptance

Highly automated, but not completely driverless, vehicles that retain a human driver in the control/responsibility loop may be sufficient for many vehicle purchasers for many years. Particularly with regard to passenger vehicles, there may turn out to be a consumer-market “stickiness” at levels of vehicle automation that are less than fully driverless. Consumers may be satisfied with highly automated driver assistance, and on-demand self-driving modes in certain circumstances, but still prefer to retain control over their own vehicles.

Some generations of car buyers, for whom a driver’s license typically crowned their adolescence, may not be as eager to leave car operation to the car. Other potential driverless vehicle buyers express feelings of insecurity if vehicle control is not in the hands of a human driver. In addition to anxieties about an “uncontrolled” driverless vehicle, some consumer skepticism about driverless passenger cars undoubtedly reflects legal uncertainties, as well as concerns about safety and financial risks. A generational change in car purchasers to those whose personal attachment to vehicle

¹⁸⁶ Driverless vehicles are classified as NHTSA 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 initially 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.

Similarly, driverless vehicles occupy SAE Level 5: Full Automation, which refers to driverless vehicles as involving “the 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.”

driving is more attenuated, as well as changes in legal regimes, are likely to be required before driverless vehicles become widespread consumer choices over highly automated driver-assisting vehicles.

In addition to psychological reluctance to relinquish control over personal mobility, legal consequences of having no human driver in control, or potential control, of a passenger car are pervasive. In some areas of law, such as vehicle regulation and insurance, driverless vehicles may require entirely new legal rules. Gradual legal-system adaptation to vehicle automation—such as acceptance of limited self-driving modes or part-time driver passivity—would provide valuable experience in guiding legal changes that will be needed before large numbers of completely driverless vehicles operate on United States roadways.

Although driverless vehicle market penetration estimates¹⁸⁷ vary a great deal, some type of fully driverless vehicles (passenger cars or trucks) are expected to be commercially available by around 2025.¹⁸⁸ Some estimates indicate that driverless vehicles will not become standard until the 2050s, because of the rather slow vehicle replacement rate. By 2050, driverless vehicles are expected to account for over half of vehicle travel.¹⁸⁹

B. Driverless Vehicle Technologies

Interaction among many types of technologies will enable driverless vehicles to operate on public roads without being operated by human drivers. The complexities of these technical systems will present unusual challenges to courts and legislatures tasked with creating and applying legal rules regarding driverless vehicles.

The following description of driverless vehicle technologies is homocentric. It starts with the interface between a human user and a driverless vehicle, then considers several types of data input technologies, as well as automated controls over vehicle functions and the artificial intelligence technologies that integrate data input and determine when and how to activate automated vehicle controls. This discussion will consider five groups of technologies that combine to operate a driverless vehicle:

¹⁸⁷ See, e.g., ERNST & YOUNG, DEPLOYING AUTONOMOUS VEHICLES: COMMERCIAL CONSIDERATIONS AND URBAN MOBILITY SCENARIOS (2014), [http://www.ey.com/Publication/vwLUAssets/EY-Deploying-autonomous-vehicles-30May14/\\$FILE/EY-Deploying-autonomous-vehicles-30May14.pdf](http://www.ey.com/Publication/vwLUAssets/EY-Deploying-autonomous-vehicles-30May14/$FILE/EY-Deploying-autonomous-vehicles-30May14.pdf).

¹⁸⁸ XAVIER MOSQUET, THOMAS DAUNER, NIKOLAUS LANG, MICHAEL RÜBMAN, MEI PACHTLER, RAKISHITA AGRAWAL & FLORIAN SCHMEIG, REVOLUTION IN THE DRIVER’S SEAT: THE ROAD TO AUTONOMOUS VEHICLES 7 (2015) (hereinafter “BOSTON CONSULTING GROUP REPORT”).

¹⁸⁹ TODD LITMAN, AUTONOMOUS VEHICLE IMPLEMENTATION PREDICTIONS IMPLICATIONS FOR TRANSPORT PLANNING 12 (2015), <http://www.vtpi.org/avip.pdf>.

1. Human-vehicle interface.
2. Sensors that provide data about internal operation of the vehicle and its parts.
3. Sensors that provide location and real-time external roadway environment data.
4. Automated controls over vehicle functions and operation.
5. Artificial intelligence that integrates in-vehicle operational data with external roadway data and activates automated vehicle controls.

Each of these groups of vehicle technologies presents multiple challenges to the legal system. Integrating these technologies to operate a driverless vehicle poses additional technical and legal challenges.

1. Human-Vehicle Interface

The points at which a human user interacts with a driverless vehicle will be crucial in determining legal responsibility. These interaction points, also called HMI (human-machine-interface), will be the loci of human choices regarding driverless vehicles. It is likely that, at least at first, driverless vehicles will involve a simple HMI that provides no choices other than to use the driverless vehicle or not to use it and to select the vehicle's destination. That interface may be biometric (a fingerprint reader or speaker recognition) or may take the form of a fob, a push button, password entry, or other on-off control. For security purposes, at least two means of verification (access factors) are likely to be required. In some jurisdictions, testing regulations provide that a human person turning on a driverless vehicle makes that human the legal "operator" of the driverless vehicle.¹⁹⁰

It seems likely that manufacturers will program early driverless vehicles in standard ways. At some point in their development, driverless vehicles may provide more complex interactions between humans and driverless vehicles than simply activating the vehicle and setting its destination. Experimental driverless vehicles are generally programmed to obey all traffic signs and rules, to avoid crashes, to stay in their appropriate lanes, etc.

It is likely that driverless car users will want to be able at least to change the vehicle's destination during a journey, when the purpose for a trip changes. These and other programming choices could cause a driverless vehicle to operate in ways that uniquely respond to individual users' personalities and preferences.

¹⁹⁰ For example, under Florida law, "a person shall be deemed to be the operator of a driverless vehicle operating in driverless mode when the person causes the vehicle's driverless technology to engage, regardless of whether the person is physically present in the vehicle while the vehicle is operating in driverless mode." FLA. STAT. § 316.85 (2014).

Unless legal requirements restrict the programming of production versions to a standard driving mode, driverless vehicles could offer a menu of alternative programming that would provide choices among different driving styles. For example, a driverless car user could select among such driving styles as "aggressive driving," "slow driving," "scenic routes," or "arrival by <specified time> at all costs." Although default driverless vehicle programming is expected to direct "safest and most time- and fuel-efficient, while obeying all traffic laws," programming alternatives are inevitable. These user alternatives would provide choices among specific ways in which the driverless vehicle functions, based on different coding menus provided by programmers. Absent legal restrictions on permitted and unpermitted driverless vehicle computer code, experimentation by programmers and hackers seems inevitable. Laws, regulations, or purchase contracts forbidding particular types of driverless vehicle programming or reprogramming would be difficult to write and to enforce, but may be on the horizon.

Increased human choices regarding how a driverless vehicle operates will generate human responsibility, including legal responsibility, for choosing more or less risky driverless vehicle operating modalities. Future driverless vehicle laws or regulations may well require specified programming limitations (e.g., always abide by all traffic laws and signals) or provide safe harbors that limit legal liability of driverless vehicle users if specified programming is used. However, at present such laws or regulations do not exist. Although ethical obligations of driverless vehicle programmers have been discussed, legal rules governing such matters have not been drafted.

2. Sensors Providing Internal Vehicle Operation Data

Sensors that detect and process the operation of various vehicle parts, such as the brakes, transmission, steering, throttle, tires, and the like are already embedded in all modern vehicles.¹⁹¹ Thousands of sensor microprocessors communicate over the CAN bus (under ISO 11898 standards) for vehicle coordination, diagnostic, and other purposes.¹⁹²

The capacities and configurations of these sensors are typically proprietary information closely held by

¹⁹¹ Robert N. Charette, *This Car Runs on Code*, IEEE SPECTRUM (Feb. 1, 2009), <http://spectrum.ieee.org/transportation/systems/this-car-runs-on-code>.

¹⁹² Steve Corrigan, *Introduction to the Controller Area Network (CAN)* (July 2008), <http://www.ti.com/lit/an/sloa101a/sloa101a.pdf>. ISO 11898-1:2003, "Road vehicles—Controller area network (CAN)—Part 1: Data link layer and physical signaling" is available through http://www.iso.org/iso/catalogue_detail.htm?csnumber=33422.

vehicle manufacturers.¹⁹³ Because these sensors function as evaluators of the internal mechanical operations of a vehicle and its parts, the information they generate can have significant legal consequences in terms of causing, diagnosing, or isolating vehicle malfunctions. These internally facing sensors also provide points of access for intruders to insert malicious code that could misdirect or even take control of a driverless vehicle. Recent reports about remote carhacking¹⁹⁴ illustrate this security vulnerability, which also is discussed in Section VII.

3. 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 driverless cars. 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 to geographically locate a driverless vehicle within a few centimeters.¹⁹⁵ In addition to GPS, precise location information mostly comes from dynamic digital mapping. Experimental driverless vehicles generate, as well as use, digital maps of roadways. Precise, real-time mapping, tracking, and other “environmental awareness” technologies used by driverless vehicles are essential to safe vehicle operation.¹⁹⁶ As a result, most driverless cars will routinely receive as well as generate mapping updates at frequent intervals. It is possible that this dynamic mapping data could be provided as cloud-sourced driverless vehicle roadway data.

¹⁹³ Much of this proprietary data is protected as trade secrets. The software that operates vehicle systems is copyrighted. As discussed in Section VII.C, *infra*, at note 546, vehicle manufacturers are objecting to a U.S. Copyright Office proposal to exempt decompiling and modifying this software from being considered illegal tampering with anti-circumvention measures that protect digital barriers against copyright infringement.

¹⁹⁴ Andy Greenberg, *Hackers Remotely Kill a Jeep on the Highway—With Me in It*, WIRED (July 21, 2015), <http://www.wired.com/2015/07/hackers-remotely-kill-jeep-highway/>. As a consequence, over a million vehicles were subject to a product recall in which software updates were sent to their owners. Andy Greenberg, *After Jeep Hack, Chrysler Recalls 1.4M Vehicles for Bug Fix*, WIRED (July 24, 2015), <http://www.wired.com/2015/07/jeep-hack-chrysler-recalls-1-4m-vehicles-bug-fix/>.

¹⁹⁵ William Messner, SAE INTERNATIONAL & AUVSI, AUTONOMOUS TECHNOLOGIES: APPLICATIONS THAT MATTER 11, 108–89 (2014).

¹⁹⁶ Greg Miller, *Driverless Cars Will Require a Totally New Kind of Map*, WIRED (Dec. 15, 2014), <http://www.wired.com/2014/12/nokia-here-autonomous-car-maps/>; Vince Bond Jr., *Up-to-the-minute maps will be critical for driverless cars*, AUTOMOTIVE NEWS (Sept. 13, 2014), <http://www.autonews.com/article/20140913/OEM06/309159962/up-to-the-minute-maps-will-be-critical-for-driverless-cars>.

Experimental driverless vehicles depend on outward-facing sensors that collect real-time data about what is happening in the immediate and longer-range roadway environment through which a driverless vehicle is moving. For example, Google has a specific patented sensor process for noting and reacting to such unexpected events as cattle crossing the road.¹⁹⁷ Indeed, driverless vehicle developers have invented a variety of different types of sensors.¹⁹⁸ Multiple forms of radar, LIDAR,¹⁹⁹ infrared, sonar, and optics (digital cameras) combine to provide a detailed and robust “picture” of the immediate and farther away roadway environment. These multiple sensors operate as redundant sources that provide both static (a curb or pothole) and dynamic (bicyclist alongside) roadway data. Poor weather conditions interfere with many sensors that require line-of-sight. As a result, in some climates and circumstances, even redundant arrays of multiple sensors may fail to provide adequate roadway data for driverless cars.²⁰⁰

To supplement these sensors, wireless communications are expected also to supply roadway situational information (e.g., movement of nearby vehicles) to driverless vehicles, particularly in circumstances where weather compromises visibility. These wireless communications technologies are not sensors, but they can provide vital data about a driverless vehicle’s dynamic roadway environment.

www2.informatik.uni-freiburg.de/~grisetti/pdf/lamon06iros.pdf

¹⁹⁷ U.S. Patent 8,996,224, issued Mar. 31, 2015. See also Mary Beth Griggs, *Google’s Driverless Cars Are Learning How To Avoid Cows*, POPULAR SCIENCE (Apr. 7, 2015), <http://www.popsci.com/google-making-sure-its-driverless-cars-wont-crash-cows-0>.

¹⁹⁸ Greg Kogut, *Sensors*, in DRIVERLESS TECHNOLOGIES, *supra* note 195, at 1–13; Ryan Whitwam, *How Google’s self-driving cars detect and avoid obstacles*, EXTREMETECH (Sept. 8, 2014), <http://www.extremetech.com/extreme/189486-how-googles-self-driving-cars-detect-and-avoid-obstacles>.

¹⁹⁹ “LIDAR—Light Detection and Ranging—is a remote sensing method used to examine the surface of the Earth.” *What Is LIDAR?*, NAT’L OCEANIC AND ATMOSPHERIC ADMIN., <http://oceanservice.noaa.gov/facts/lidar.html> (last visited Sept. 20, 2015).

²⁰⁰ Doron Levin, *The cold, hard truth about driverless vehicles and weather*, FORTUNE (Feb. 20, 2015), <http://fortune.com/2015/02/02/autonomous-driving-bad-weather/>.

Section III.C.2.a discusses the potential application of connected vehicle technologies in driverless vehicles. In addition, beacon technologies, or pavement-embedded signals, may be developed to transmit to driverless vehicles information from signs and warnings about potential roadway hazards such as low bridges, tight curves, or lane closures.

4. Automated Controls over Vehicle Functions and Operation

In a driverless vehicle, control over vehicle operation is automated through networks of actuator microprocessors (sometimes called ECUs, for “electronic control units”) triggered by the vehicle’s artificial intelligence. So far, automated controls in conventional vehicles appear to have been remarkably reliable in accomplishing specific vehicle operations from anti-lock brakes to electronic stability control. However, some automated vehicle controls appear to have proved more reliable than others. For example, automatic lane-keeping controls²⁰¹ seem to be less reliable than electronic stability control.²⁰²

Media reports about technical experiments enabling remote access to automated vehicle controls have eroded public confidence in automated vehicle controls. Such vulnerabilities, associated with car-hacking, present legal as well as technical challenges for driverless vehicles. Indeed, automated controls have proved to be the most vulnerable aspect of vehicle automation to car hacking.²⁰³ The security aspects of automated controls in driverless vehicles will be discussed further in Section VII.C.

5. Artificial Intelligence

Driverless vehicles rely on highly sophisticated artificial intelligence to integrate and analyze internal vehicle operational data and roadway sensor data and then to determine which automated controls to activate. This machine ability to control all vehicle operations distinguishes driverless vehicles from other automated technologies that either assist or warn human drivers.

Driverless vehicle artificial intelligence integrates internal vehicle operational and external roadway environment inputs as described above. It

²⁰¹ Chad Kirchner, *Lane Keeping Assist Explained*, MOTOR REVIEW (Feb. 17, 2014), <http://motorreview.com/lane-keeping-assist-explained/>. It may be that lane markings are insufficiently standardized and maintained for the technology to operate properly.

²⁰² *Electronic Stability Control*, NHTSA, <http://www.safercar.gov/Vehicle+Shoppers/Rollover/Electronic+Stability+Control> (last visited Sept. 20, 2015).

²⁰³ CHARLIE MILLER & CHRIS VALASEK, REMOTE EXPLOITATION OF AN UNALTERED PASSENGER VEHICLE (2015), <http://illmatics.com/Remote%20Car%20Hacking.pdf>.

is likely that driverless vehicle artificial intelligence will be functionally distributed across multiple parts of a vehicle’s decision and control systems, rather than being located in a single central processing unit. It also will be self-learning in the sense that the algorithms used in operating a vehicle modify themselves over time in response to previous operations, new information, and feedback. Self-learning algorithms are characterized by their dynamic adaptability. Rather than robotically carrying out static programming directions, driverless vehicles analyze data, model it, and make data-driven predictions and decisions, such as actuating vehicle controls.²⁰⁴ Actuated controls simultaneously provide feedback data to various parts of the system.

So far, sufficient computational power to manage driverless vehicle data integration, analysis, and activation appears to be available and at necessary analytic speed.²⁰⁵ However, capacities for rapid data fusion and control architecture are not unlimited. In particular, the computational demands of advanced security systems needed to protect driverless vehicles from external threats may drain resources and slow analytic functioning in driverless vehicles. A driverless vehicle’s artificial intelligence is tasked with performing vehicle management and guidance functions otherwise performed by a human driver. That artificial intelligence has to be at least as accurate and reliable as human intelligence engaged in the same types of operations.²⁰⁶

At present, the legal system does not specifically regulate any of the parameters in which driverless vehicle artificial intelligence will be permitted to operate. Because artificial intelligence decisions have consequences in terms of safety, economic, and environmental impacts, this aspect of driverless cars is likely to be subject to extensive legal regulation that is not yet in existence.

C. Connected Vehicle Technologies

Various types of connected vehicle technologies (wireless communications) may provide inputs for driverless vehicle operation. As of mid-2015, it

²⁰⁴ Self-learning artificial intelligence is a type of machine learning developed in computer science. See generally Stuart Russell and Peter Norvig, ARTIFICIAL INTELLIGENCE: A MODERN APPROACH (2013).

²⁰⁵ Aaron Dubrow, *Researchers improve artificial intelligence algorithms for semi-driverless vehicles*, PHYSICS.ORG (Feb. 3, 2015), <http://phys.org/print342167574.html>.

²⁰⁶ Some of the most sophisticated applications of self-learning artificial intelligence come from DeepMind, now owned by Google, Inc. See Hannah Devlin, *Google develops computer program capable of learning tasks independently*, THE GUARDIAN (Feb. 25, 2015), <http://www.theguardian.com/technology/2015/feb/25/google-develops-computer-program-capable-of-learning-tasks-independently>.

remains undetermined which types of vehicle communications will be integrated into driverless vehicles. Driverless vehicles are not technically required to be connected vehicles. But they probably will be.

1. Vehicle Connectivity

Wireless communications systems connect vehicles with other vehicles or with other receivers located in or near the roadway around them. Various technologies provide this vehicle connectivity. Wireless technologies are already embedded in most late-model conventional cars. Cellular wireless connections offer phones, Internet access, information, and entertainment to moving vehicles. A NHTSA requirement of dedicated short range communications (DSRC) transceivers as safety equipment on all new passenger vehicles and light trucks is expected to be proposed by the end of 2015.²⁰⁷ All of these systems could provide data useful in the operation of driverless vehicles.

Ambiguous terminology frequently confuses policy decisions regarding vehicle connectivity. In the United States, “telematics” (also “automotive telematics” or “mobile telematics”) can refer generically to any form of wireless communication to or from vehicles, i.e., vehicles connected to the outside world over various types of wireless connections. For some automotive analysts, such as the consulting firm Gartner, only communications *from* vehicles are telematics: “Telematics refers to the use of wireless devices and ‘black box’ technologies to transmit data in real time back to an 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.”²⁰⁸ “Mobile telematics” can refer, even more narrowly, to connections between an automobile’s computer systems and embedded wireless communications systems that transmit vehicle operation data to the vehicle’s manufacturer or insurer. Under whatever name, telematics or various other vehicle communications technologies may be used in driverless vehicles. On the other hand, because driverless vehicles can operate without wireless communications functions, driverless vehicles need not have any such connectivity.

Indeed, some experimental driverless vehicles have been deliberately designed not to connect with external sources of information for their operation. For example, the vehicles involved in the DARPA

²⁰⁷ Transportation Sec. Foxx announces steps to accelerate road safety innovation DOT 49-15, NHTSA (May 13, 2015), <http://www.nhtsa.gov/About+NHTSA/Press+Releases/2015/nhtsa-will-accelerate-v2v-efforts>.

²⁰⁸ Gartner IT Glossary “Telematics,” GARTNER (2013), <http://www.gartner.com/it-glossary/telematics>.

2004, 2005, and 2007 Grand and Urban Challenges were not permitted to use externally communicated information for vehicle operation.²⁰⁹ One way to characterize vehicles that rely only on data generated within the vehicle, without wireless connections, is to describe them as “self-contained,” in contrast with wirelessly connected vehicles, described as “interconnected.”²¹⁰ What is not known at this time is whether future driverless cars will be interconnected²¹⁰ through reliance on wirelessly communicated data for vehicle operations.

2. USDOT Connected Vehicle Program

The United States Department of Transportation (USDOT) has an elaborate Connected Vehicle Program.²¹¹ This program is divided into two parts: 1) connected vehicle safety systems through which vehicles transmit and receive vehicle operation data over DSRC transceivers, and 2) connected vehicle mobility applications, which provide information, entertainment, and other communications over various commercial wireless networks.²¹²

USDOT Connected Vehicle Program research has also considered “multi-modal” systems combining DSRC safety data and other wireless vehicle communications platforms into a “Core System” that would connect vehicles with off-road transportation management systems and other vehicle data users.²¹³ Only a concept of operations has been prepared for such a combined Core System.

USDOT’s bifurcated Connected Vehicle Program divides DSRC wireless vehicle communications

²⁰⁹ See *DARPA Urban Challenge*, DARPA, <http://archive.darpa.mil/grandchallenge/> (last visited Sept. 20, 2015).

²¹⁰ Dorothy J. Glancy, *Privacy in Autonomous Vehicles*, 52 SANTA CLARA L. REV. 1171, 1176–78 (2012).

²¹¹ The Intelligent Transportation Systems Joint Program Office (ITS JPO) manages research aspects of the connected vehicle program within the Office of the Assistant Secretary for Research and Technology. The Office maintains a Web site on this subject at http://www.its.dot.gov/connected_vehicle/connected_vehicle_research.htm. In addition, the Federal Highway Administration Office of Operations also conducts connected vehicle research. Their connected-vehicle Web site appears at <http://ops.fhwa.dot.gov/travelinfo/infostructure/aboutinfo.htm>.

²¹² Christopher Hill, MODULE 13: CONNECTED VEHICLES 1–2 (2013), <http://www.pcb.its.dot.gov/eprimer/documents/module13.pdf> (“[I]n summary, safety-related systems in the connected vehicle environment will likely be based on dedicated short range communications (DSRC). Non-safety applications may be based on different types of wireless technology.”).

²¹³ *Connected Vehicle Core System Baseline Documentation*, OFFICE OF THE ASSISTANT SEC’Y FOR RESEARCH AND TECH., U.S. DEP’T OF TRANSP. (Sept. 16, 2015), http://www.its.dot.gov/connected_vehicle/connected_vehicle_coresystems.htm.

technologies that use closed ad hoc networks from commercial mobile wireless applications. Indeed, the wireless technologies involved are both technically and legally distinct. For example, cybersecurity vulnerabilities posed by DSRC connected vehicles are markedly different from those posed by commercial wireless mobile applications.

Referring to both categories as “connected vehicles” obscures important technical differences that affect legal policy determinations. Indeed, the legal ramifications of safety-oriented DSRC vehicle communications are unlike the legal ramifications of mobile wireless communications that provide convenience, information, and entertainment to people in existing vehicles.

a. Connected Vehicle DSRC Safety Systems.—Connected vehicle safety systems use specialized DSRC transceivers to send and receive real-time vehicle data over ad hoc V2V vehicle networks. NHTSA has announced that the agency plans to require this type of connected vehicle communications equipment in all new passenger cars and light trucks.²¹⁴

USDOT initiated DSRC connected vehicle technologies just after the turn of the 21st century, as part of a USDOT research program called VII (Vehicle Infrastructure Integration). In 1999, the Federal Communications Commission (FCC) had assigned 75 megahertz of spectrum at 5.850–5.925 GHz (often referred to as the 5.9 GHz spectrum) solely for vehicle safety and mobility communications over DSRC.²¹⁵ The initial VII concept was to provide human drivers real-time information about the infrastructure (curves, bridges, embankments), as well as what other nearby vehicles (particularly not yet visible vehicles) were doing. The VII program developed a DSRC radio communications system over the FCC-allocated radio spectrum. DSRC radio technology has the capacity to transmit vehicle operation data at high speeds and with low latency. DSRC communications between a vehicle and the roadside infrastructure are called V2I. DSRC communications from one vehicle to another vehicle are called V2V. DSRC communications that transmit vehicle data to all sorts of mobile devices are called V2X. In all cases, DSRC’s function is wireless transmission of vehicle

²¹⁴ 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) (hereinafter “NHTSA ANPRM”). See also NHTSA, *supra* note 207.

²¹⁵ 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).

operational data. This data can provide useful operational inputs for driverless vehicles.

In 2014, NHTSA announced a regulatory initiative to require DSRC “Connected Vehicle” radio transceivers as mandatory safety equipment in all new passenger vehicles and light trucks in the United States.²¹⁶ This announced, but not yet formally proposed, mandatory V2V safety requirement is not aimed specifically, much less solely, at driverless vehicles. According to NHTSA, required V2V operational data will be exchanged anonymously over ad hoc networks for the purpose of warning drivers of conventional vehicles.²¹⁷ Still, such a DSRC requirement would also provide driverless vehicles a valuable source of real-time data about nearby vehicle operations.

Four serious uncertainties cloud the potential for near-term requirements regarding DSRC connected vehicle V2V safety data transmissions. First, the FCC is under Congressional pressure to re-allocate parts of the now-dedicated 5.9 GHz DSRC spectrum to other types of wireless users.²¹⁸ Other, non-vehicle uses of this spectrum could cause interference that would degrade the usefulness of DSRC real-time vehicle communications to the point that that V2V Connected Vehicle communications could become unreliable, particularly in congested urban areas. Interference issues continue to be under study.²¹⁹

Second, when NHTSA announced the agency’s intention to require connected vehicle DSRC transceivers in all passenger vehicles and light trucks,

²¹⁶ NHTSA ANPRM, *supra* note 214. See also NAT'L HIGHWAY TRAFFIC ADMIN., U.S. DEPT' OF TRANSP., VEHICLE-TO-VEHICLE COMMUNICATIONS: READINESS OF V2V TECHNOLOGY FOR APPLICATION xiii (2014) (hereinafter “NHTSA Readiness Report”) <http://www.nhtsa.gov/staticfiles/rulemaking/pdf/V2V/Readiness-of-V2V-Technology-for-Application-812014.pdf>.

²¹⁷ NHTSA ANPRM, *supra* note 214, 79 Fed. Reg. 49,270, 49,272 (“[W]e plan to propose to require that new vehicles be equipped with DSRC devices, which will enable a variety of applications that may provide various safety-critical warnings to drivers.”).

²¹⁸ 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 also Rebecca Blank & Lawrence E. Strickling, U.S. DEPT' 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* (Jan. 2013), http://www.ntia.doc.gov/files/ntia/publications/ntia_5_ghz_report_01-25-2013.pdf.

²¹⁹ Michael O’Rielly & Jessica Rosenworcel, *Driving Wi-Fi Ahead: the Upper 5 GHz Band*, OFFICIAL FCC BLOG (Feb. 23, 2015), <https://www.fcc.gov/blog/driving-wi-fi-ahead-upper-5-ghz-band>.

substantial objections were raised about the continuing absence of adequate measures to protect both privacy and security as well as to prevent the use of V2V for surveillance. Some of these privacy, security, and surveillance concerns are based on DSRC connected vehicle design features in which unencrypted vehicle operational data (the Basic Safety Message, or BSM) are transmitted “in the clear” from vehicle to vehicle. See Section VII, infra, for a discussion of these issues in greater detail.

Third, there are legal objections to NHTSA’s announced intention to propose agency regulations that would require a DSRC transceiver to be embedded in every new passenger vehicle and light truck. There is no express statutory authorization for such an agency requirement.²²⁰ The need for legislative authorization further increases the possibility that NHTSA’s intended DSRC connected vehicle requirement may be delayed or even blocked by Congress.

Fourth, some transportation technology experts are beginning to view DSRC as 1990s technology that needs reassessment in light of newer and better communications technologies.²²¹ So far, alternative communication technologies, such as those used in commercial mobile wireless applications described below, have not yet attained the speed and low latency that make DSRC essential for vehicle safety communications. Nevertheless, improvements in commercial mobile wireless technologies may provide alternative ways to transmit specialized vehicle operation data wirelessly in real-time.²²² If such improved wireless communications technologies can attain the functionality of DSRC, driverless vehicles may transmit and receive vehicle safety data over these wireless channels, instead of the currently planned connected vehicle DSRC safety systems.

b. Connected Vehicle Wireless Mobility Applications (Mobile Wireless).—Connected Vehicle Wireless Mobility Applications (Mobile Wireless) are

²²⁰ 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>. See also RAND REPORT, *supra* note 181, at 100 (discussing limitations to NHTSA regulatory authority).

²²¹ Brad Templeton, *Will Robocars Use V2V at All?*, ROBOHUB (Feb. 3, 2015), <http://www.automotiveitnews.org/articles/share/559041/>.

²²² *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* 1, 5–8 (2014), http://object.cato.org/sites/cato.org/files/pubs/pdf/pa758_1.pdf (describing the extensive driving data most drivers already get from mobile wireless technology through platforms such as Google Maps, Apple Maps, and various weather mobile apps).

different from the narrowly focused, standardized DSRC Connected Vehicle Safety Systems discussed in the previous section. Mobile wireless communications comprise a heterogeneous group of technologies using commercial wireless networks (currently 4G and LTE, but by the time driverless vehicles are introduced, probably some form of 5G). These wireless technologies send and receive a wide range of data, including navigation assistance, traffic, weather, phone conversations, email, and entertainment programming, as well as vehicle operation data. Mobile wireless services also include satellite services, such as Sirius XM Satellite Radio, that transmit digital signals into moving vehicles, under circumstances where slower transmission speeds and higher latency do not interfere with the purpose of the transmission. For short distances within a vehicle, Bluetooth is typically used for wirelessly communicating among devices.

Mobile wireless technologies, such as smartphones, can be brought into a vehicle to provide navigation and other information to enhance vehicle mobility and convenience. Applications include existing commercial services that provide navigation and parking advice, automatic accident reporting, weather, and traffic reports. Some wireless services provide only audio-video entertainment and information. Others facilitate Internet connections.

Apple and Google provide the two main vehicle platforms that allow smartphone (phone and Internet) functions to appear on a vehicle’s dashboard display screen and enable smartphone control by using the vehicle’s controls, including voice controls. Apple’s interface, called CarPlay, was launched in March 2014. Google’s similar interface, called Android Auto, launched in June 2014.

In addition, many vehicle manufacturers embed closed-network wireless communications platforms that automatically communicate data regarding vehicle parts and operations back to the vehicle’s manufacturer. Some of these closed wireless systems also carry infotainment, navigation, and automatic crash notification (ACN) services. Automotive operating systems that have been used to run this type of embedded vehicle connectivity include Microsoft Embedded Automotive, open-source MeeGo, and QNX Car from Research in Motion. The most advanced vehicle-embedded communications systems offer cross-platform mobile access to phone, Internet sites, infotainment, and email, as well as provide data communication between a vehicle’s automotive systems and its manufacturer. Hackers used this communications feature in a Jeep Cherokee to tap into vehicle control systems so that they

could remotely take over operational control of the vehicle while it was being driven on a highway.²²³

In March 2014, the Federal Highway Administration (FHWA) published a *Federal Register* Notice requesting information about Connected Vehicle Mobility Applications “that leverage the full potential of trusted communications among connected vehicles, travelers, and infrastructure to better inform travelers, enhance current operational practices, and transform surface transportation systems management.”²²⁴ This research program seeks “applications that synergistically capture and utilize new forms of connected vehicle and mobile device data to improve multimodal surface transportation system performance and enable enhanced performance-based systems management.”²²⁵ FHWA apparently seeks to leverage connected vehicle data for use in commercial applications, as well as traffic management and safety programs.

In 2015, USDOT launched a connected vehicle research program to encourage “Dynamic Mobility Applications.” This USDOT program will “combine connected vehicle and mobile device technologies in innovative and cost-effective ways to improve traveler mobility and system productivity, while reducing environmental impacts and enhancing safety.”²²⁶ The Dynamic Mobility Applications program envisions competitive commercial development, with the federal government playing “an appropriate and influential role as a technology steward for the continually evolving integrated transportation [information] system.”²²⁷ The program seeks development of ways to use connected vehicle data for traveler convenience, safety, environmental, and transportation management functions.

USDOT encourages, but does not generally regulate, Mobile Wireless applications, except insofar as they may pose safety hazards in the form of driver distractions. In 2013, NHTSA published voluntary guidelines that restrict visual and tactile access to many types of in-vehicle wireless devices and displays, such as those used in Mobile Wireless applications.²²⁸ Because these guidelines only affect driver-facing interfaces, they will not apply to driverless vehicles. Since automated, semi-autonomous, or partly self-driving vehicles all have drivers subject

²²³ MILLER & VALASEK, *supra* note 203, at 20–33. The system hacked was a QNX-based system called Uconnect.

²²⁴ Connected Vehicle Pilot Deployment Program; Request for Information, 79 Fed. Reg. 14105, 14105 (Mar. 12, 2014).

²²⁵ *Id.*

²²⁶ *Connected Vehicles CV Pilots Deployment Project*, U.S. DEP’T OF TRANSP. (Nov. 7, 2014), http://www.its.dot.gov/pilots/cv_pilot_progress.htm.

²²⁷ *Id.*

to distraction, the driver distraction guidelines would apply. So far, NHTSA has brought no formal enforcement actions related to Mobile Wireless applications that have allegedly distracted drivers of conventional cars. Nevertheless, NHTSA has warned that the agency may initiate enforcement if in-vehicle electronic devices contain safety-related defects or cause driver distraction when human drivers are in control of vehicles.

3. FCC Communications Regulation

The FCC allocates the communications spectrum and licenses both telecommunications devices and wireless telecommunications carriers that transmit communications to and from vehicles. In addition, the FCC’s E911 regulations, adopted in 2010, require wireless mobile phone communications to provide location information (primarily from GPS).

Although there have been suggestions that the FCC adopt specific licensing regulations with regard to providers of vehicle-based mobile wireless services (which the FCC generally refers to as telematics), the FCC has so far only asserted general jurisdiction over wireless communications devices and wireless service providers. Aside from licensing the 5.9 GHz spectrum (5.850–5.925 GHz) for use by DSRC vehicle safety and mobility services, the FCC does not yet specifically regulate connected vehicle communications platforms. Further regulation of vehicle communications systems by the FCC is possible, as communications from connected vehicles become more widespread.²²⁹

4. Vehicle Connection Security Issues

Among the most serious challenges faced by connected vehicles, whether human-driven or driverless, are heightened cybersecurity threats. In the context of Mobile Wireless applications, security threats can be difficult to guard against because there are so many sources both of data input and of types of communications. In a multi-connection wireless communications setting, identifying, isolating, and preventing security threats from hackers, malware, defective equipment, and other cybersecurity threats is especially difficult. See Section VII, *infra*.

According to a recent report, “A new car may have more than 145 actuators and 75 sensors, which produce more than 25 GB of data per hour. The data is analyzed by more than 70 onboard computers to

²²⁸ Visual-Manual NHTSA Driver Distraction Guidelines for In-Vehicle Electronic Devices, 78 Fed. Reg. 24818 (Apr. 26, 2013).

²²⁹ See the discussion of potential FCC privacy regulation, *infra* at notes 508–511.

ensure safe and comfortable travel.”²³⁰ Connected vehicle mobility applications access this vehicle data to provide feedback data to the manufacturer of the vehicle. They also offer attractive hacker targets.

Mobility applications often include “infotainment systems, engine management units, and onboard diagnostic units, radios operating at different frequencies, GPS receivers, transponders, Bluetooth devices, and cell phone chips.” As a result, “malware in any subsystem could compromise the safety of not only the people in the car, but also those around them.”²³¹ Research is underway with regard to potential security threats in the context of connected vehicle communications systems. Development of security solutions for connected vehicle communications is discussed in Section VII, infra.

D. Manufacture and Sales

It is unlikely that automobile original equipment manufacturers (OEMs) will build everything that goes into driverless vehicles, including all parts and systems. Instead, driverless vehicle manufacturers will, almost certainly, integrate parts and technologies from component manufacturers into driverless vehicles.²³² Specialized companies, such as Bosch, Continental, and many other vehicle parts suppliers, are developing driverless and automated vehicle parts and modules.²³³ Technology companies, such as Google, Inc., also develop components or modules for assembly into the company’s driverless vehicles. Because of the need to integrate multiple automated systems within a driverless vehicle, it is most likely that driverless cars and trucks will be manufactured solely as original equipment, rather than as aftermarket driverless vehicle retrofit modules or kits.²³⁴

²³⁰ Max Glaskin, *Safe and Secure*, VISION ZERO INT'L, June 2014, at 40.

²³¹ *Id.*

²³² Gabe Nelson, *Google in talks with OEMs, suppliers to build self-driving cars*, AUTOMOTIVE NEWS (Jan. 14, 2015), <http://www.autonews.com/article/20150114/OEM09/150119815/google-in-talks-with-oems-suppliers-to-build-self-driving-cars>.

²³³ Joseph Szczesny, *Continental Ups the Autonomous Car Ante*, THE DETROIT BUREAU (Aug. 18, 2014), <http://www.thedetroitbureau.com/2014/08/continental-ups-the-autonomous-car-ante/>. 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/>.

²³⁴ Installation of driverless vehicle components is probably too difficult to make aftermarket versions of driverless vehicles realistic. Michigan law exempts from liability for injuries from product defects not present at the time of manufacture both manufacturers and subcomponent manufacturers if vehicles are converted into automated motor vehicles. MICH. COMP. LAWS § 600.2949b (2014).

Most conventional cars and trucks are currently sold through intermediaries, known as dealers. It is possible that some driverless cars will be sold directly by automobile companies, rather than through dealers. For example, Tesla Motors currently markets its advanced electric cars directly to purchasers, without an intermediary dealer. The vehicle manufacturer handles continuing warranty service and maintenance. In driverless vehicles, software, such as mapping, is likely to require continuing maintenance and more frequent updating than physical aspects of the vehicle. Frequent software and firmware updates for driverless vehicles are expected to be wirelessly downloaded from manufacturers.

Continuing need for updates, mapping, and other programming modifications may tether a driverless vehicle to its manufacturer throughout the life of the vehicle. As discussed elsewhere in this report, the need for ongoing changes in driverless vehicle programming and systems are likely to affect products liability for harm resulting from driverless vehicle programming modifications. Virtually continuous vehicle information exchanges with manufacturers through mobile wireless communications is already a common feature of some advanced motor vehicles, particularly electric vehicles.²³⁵

E. Vehicles Not Considered Driverless Vehicles

Before the driverless vehicles discussed in this report become available, several forms of highly automated vehicles will likely be in use. As discussed earlier, part-time or partially self-driving vehicles are not, for the purposes of this report, considered driverless vehicles.

1. Vehicle Platoons

Vehicle platooning has been a subject of enthusiastic discussions for a long time. Applications of vehicle platoons, from truck convoys to “car-trains,” rely on wireless communications connecting one platooned vehicle with the next, and the rest of the chain. These vehicles currently require human drivers to manage entry into and exit from the platoon, although platooned vehicles are not under active driver control during the part of the journey when they are attached to the platoon. For the purposes of this report, platooning is an example of a highly promising connected vehicle technology that provides opportunities for a degree of human driver passivity. However, a vehicle in a platoon is not a driverless vehicle, in the sense that a human driver

²³⁵ See Francesca Svarcas, *Turning a New LEAF: A Privacy Analysis of CARWINGS Electric Vehicle Data Collection and Transmission*, 29 SANTA CLARA COMP. & HIGH TECH. L.J. 165 (2012).

is entirely superfluous. In the future, driverless vehicles may be able automatically to attach and detach from vehicle platoons. But that does not appear to be a near-term option.

Early applications of this technology have been developed as truck platoon systems such as that provided by Peloton Technology in the United States.²³⁶ In Europe, the European Commission established the SARTRE Project (Safe Road Trains for the Environment). Successfully developed SARTRE vehicle platoons operated on normal public highways and demonstrated significant environmental, safety, and comfort benefits, mostly in the context of long-haul trucking.²³⁷

Since a follow-the-lead-truck approach still retains drivers, it does not involve vehicles that are, in present versions, driverless. A driver operates the lead truck; in the following trucks, drivers remain in the vehicles, although they do not exercise active vehicle control while they are in the platoon.

In the United States, legal impediments to lawful operation of truck platoons take the form of state laws that specifically ban “truck convoys.”²³⁸ Other state statutes set specific minimum spaces between vehicles under “following too close” prohibitions.²³⁹

2. Remotely Controlled Vehicles

Remote control over a vehicle by an external operator does not make the vehicle driverless. Although no human driver may be present in the vehicle, a remotely controlled vehicle does not control its own

²³⁶ PELOTON, <http://www.peloton-tech.com/about/> (last visited Sept. 20, 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.

²³⁷ SARTRE PROJECT, <http://www.sartre-project.eu/en/Sidor/default.aspx> (last visited Sept. 20, 2015). See also Ian Norwell, *Road Trains on Track?*, TRANSP. ENGINEER (Apr. 28, 2014), <http://www.transportengineer.org.uk/transport-engineer-features/road-trains-on-track/60995>.

²³⁸ 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.”).

²³⁹ 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.

operation. Control by external operators simply moves the vehicle’s “driver” from being a human inside the vehicle to someone outside the vehicle.

Remotely controlled vehicles are often associated with familiar childhood toys. In commercial versions, they are used in mining and military operations, often in the form of very large-scale trucks, digging equipment, and UGVs (unmanned ground vehicles).²⁴⁰ In the context of rail transport, remote control of trains has been a controversial feature of railroad operation for a long time, partly because of job displacement of human train operators.²⁴¹

This report instead focuses on driverless vehicles whose operations are not controlled by any human driver either inside or outside the vehicle.

F. Driverless Vehicle Uses and Deployment

Slightly different legal rules and policies will apply to different ways in which driverless vehicles may be used. For example, driverless trucks in interstate commerce likely will be subject to federal regulation with regard to minimum insurance requirements; driverless passenger cars will instead be subject to state insurance regulation.

Potential uses for driverless vehicles include:

- Individually owned personal/family transportation;
- On-demand personal-mobility services in urban areas;
- Rental vehicles for short-term mobility and transport needs;
- Long-haul movement of goods and commodities;
- Commercial local delivery services;
- Paratransit driverless vehicles (services for persons with disabilities);
- Fleets owned by corporations or other entities;
- Fleet ownership by groups of users for cooperative use; and
- Urban low speed vehicles on limited roadways.

²⁴⁰ 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—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), http://www.riotinto.com/media/media-releases-237_10603.aspx. The mining trucks Rio Tinto claims to be “autonomous” are in fact operated by remote control. *Id.*

²⁴¹ FED. RAILROAD ADMINISTRATION, 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, DOT/FRA/ORD-06/08 (2006).

Which of these driverless vehicle uses will develop earliest and which applications would provide the most demand for driverless vehicles is difficult to predict. However, it is possible to sort out some of the factors and circumstances likely to encourage use of driverless vehicles, as well as some factors that would tend to discourage use of driverless vehicles.

1. Factors Encouraging Driverless Vehicle Use

Factors that are likely to encourage driverless vehicle market interest or to stimulate purchase of driverless vehicles will include enhanced safety, convenience, and efficiencies such as the ability of riders to perform other tasks or to rest.

Availability of fleets of driverless vehicles for on-demand use appears to be attractive to many potential users, particularly in urban areas. Repeated journeys along the same roads (commuting to work or to school), frequent slow-moving traffic or traffic stoppages, opportunities to multitask or to do nothing, as well as individual personal preferences for solitary personal mobility without a human driver are all likely to encourage interest in purchasing or using a driverless vehicle.

These factors tend to be present primarily in urban and suburban settings. More intense use of urban area roadways will tend to increase the accuracy of real-time roadway maps and to provide more data sources regarding traffic and weather conditions. Special road markings, or beacons, automatically transmitting data to driverless vehicles would also be more economically justifiable in higher-use urbanized areas. Overall, economies of scale suggest more densely traveled areas as more conducive for use by driverless vehicles.

Because driverless vehicles will generate quite a number of public goods such as environmental and public safety benefits,²⁴² tax or regulatory incentives may provide an additional factor encouraging purchase of driverless vehicles.

2. Factors Discouraging Driverless Vehicle Use

Factors likely to discourage interest in driverless vehicles include cost; psychological queasiness about loss of control; roadway risks from other vehicles and the infrastructure, as well as from non-vehicle road users (pedestrians, bicycles, etc.); concerns about surveillance and tracking of individuals; and insecurity about potential defects in and hacker attacks on driverless vehicle technical systems. It is unclear whether driverless vehicles will be preferred for long or short journeys. Initially, driverless vehicles may be rarely used until controlled operating

environments, such as segregated roadways for driverless vehicles, are established.

At the outset, increased cost will be an important factor discouraging many would-be purchasers of driverless vehicles. According to Morgan Stanley analyst Ravi Shanker, at today's prices, full driverless capability is estimated to add about \$10,000 to the cost of a car.²⁴³ The Boston Consulting Group estimates that in 2025 a driverless vehicle will add \$9,800 to the vehicle's base price.²⁴⁴ Increased production of driverless vehicles should bring costs down.

Corporate or cooperative purchases of driverless vehicles for on-demand use will face uncertainties about demand patterns, as well as high front-end capital costs.

3. Specialized Driverless Vehicle Environments

In the transition to widespread use of driverless vehicles, these vehicles will have to be able to cope with human-driven vehicles. As noted earlier, at least initially, driverless vehicles may first be used in special controlled environments, such as areas restricted to low-speed vehicles or restricted travel lanes.

a. Urban Personal Mobility On-Demand Services. —When people are asked about the type of driverless vehicles they want to be available first, they usually point to on-demand personal mobility services for short trips.²⁴⁵ On-demand driverless car services promise convenience and privacy in transporting people to and from local destinations in urban areas where population density makes such transport-on-demand profitable. Existing online ride services, which are sometimes called "ride-sharing," "ride-hailing," or "Transportation Network Companies" (TNCs), are smartphone applications popularized by Uber, Lyft, Sidecar, and similar ventures. They are a frequently mentioned business model for use of driverless vehicles. Summoning a vehicle without a driver seems to be both potentially

²⁴³ Morgan Stanley, *Autonomous Cars: The Future is Now* (Jan. 23, 2015), <http://www.morganstanley.com/articles/autonomous-cars-the-future-is-now/>.

²⁴⁴ BOSTON CONSULTING GROUP REPORT, *supra* note 188, at 15.

²⁴⁵ See, e.g., Antonio Loro, *Driverless Taxis: The Next Next Big Thing in Urban Transportation?*, PLANETIZEN (May 6, 2014), <http://www.planetizen.com/node/68657>. See also Bora Alp Baydere, Kelechi Erondu, Daniel Espinel, Siddarth Jain & Charlie Ritter Madden, Car-Sharing Service Using Autonomous Automobiles 3 (Spring 2014) (unpublished manuscript), <http://web.stanford.edu/class/me302/PreviousTerms/2014-06Car-SharingServiceUsingAutonomousAutomobiles%28paper%29.pdf>.

²⁴² RAND REPORT, *supra* note 181, at 9.

more reliable and more private than current online ride-service programs in which vehicles come with human drivers. Variations on use of on-demand driverless vehicles appear likely to include cooperatives in which fleets of driverless vehicles are owned in common by groups and made available for personal or shared use by members of a driverless vehicle cooperative.

Indeed, driverless vehicles could well become the main type of vehicle used in online on-demand ride services, an increasingly popular form of spontaneous personal mobility. To the extent that such transportation services replace personal vehicle ownership, such a transformation would reflect fundamental changes in expectations about personal mobility. Instead of purchasing a machine that requires maintenance and garage space, personal mobility could become a service that requires neither. Some studies of millennials indicate a shift toward such a preference for personal transportation as a service, as opposed to personal mobility through individual vehicle ownership.²⁴⁶

b. Small Low-Speed Driverless Vehicles.—In mid-2015, Google, Inc., began to take delivery of a fleet of small, low-speed vehicles.²⁴⁷ The company intends to license these two-person vehicles in California, once the California Department of Motor Vehicles has adopted regulations that permit their licensing for on-road operation, enabling general operation of these driverless vehicles on public roadways. Google managers note that the corporation does not plan to go into the business of driverless car manufacturing. Rather, at least initially, the corporation plans to own and use its fleet of 100 or so driverless vehicles to transport employees and visitors on and around the corporation's campus. For regulatory purposes, these driverless cars are categorized as low-speed vehicles (LSVs) limited to top speeds between 20 and 25 miles per hour. NHTSA regulates these LSVs under a special regulatory category for lighter, limited-speed vehicles, such as golf carts, under Motor Vehicle Safety Standard No. 500, which authorizes small, light vehicles restricted to speeds under 25 miles per hour.²⁴⁸

Low speed driverless vehicles will be limited to use on protected and well-mapped routes.

²⁴⁶ AMERICAN PUBLIC TRANSPORTATION ASSOCIATION, MILLENNIALS & MOBILITY: UNDERSTANDING THE MILLENNIAL MIND-SET (2013), <http://www.apta.com/resources/reportsandpublications/Documents/APTA-Millennials-and-Mobility.pdf>.

²⁴⁷ Mark Harris, *Google reveals plans to increase production of self-driving cars*, THE GUARDIAN (Sept. 12, 2015), <http://www.theguardian.com/technology/2015/sep/12/google-self-driving-cars>.

²⁴⁸ Low Speed Vehicles, 49 C.F.R. § 571.500 (2011).

Whether such an application of driverless vehicles can be extrapolated to broader consumer uses remains to be seen. If consumer models of driverless vehicles are limited to the LSV regulatory category of small, light, low-speed vehicles, the potential consumer market may also be limited to retirement and other planned communities that emphasize alternatives to conventional automobiles.²⁴⁹ On the other hand, in some large cities, such as New York, the maximum speed limit is already 25 miles per hour.²⁵⁰ In such congested urban cores, small, low-speed, few-passenger driverless vehicles would be especially attractive mobility options for local trips.

c. Controlled Roadway Environments for Driverless Vehicles.—In order to minimize legal risks that may result from personal injuries, property damage, or other adverse interactions with unpredictable human drivers and pedestrians, driverless vehicles may work best in controlled environments, in which vehicle movements and roadway events are more predictable. Segregated roadways with few or no pedestrians or other road users, where all vehicles are driverless and where road closures, construction, or repairs are infrequent and mapped in advance, may be the most efficient near-term way to deploy driverless vehicles.

In a longer timeframe, probably before the beginning of the next century, all vehicles may be required to be driverless. Human-driven vehicles may be prohibited from using most public roadways, just as horses are often prohibited on urban streets.

IV. CIVIL LIABILITY FOR PERSONAL INJURY

For as long as they have been imagined, driverless vehicles have been perceived as a panacea to the safety hazards associated with their human-operated

²⁴⁹ 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 (2010).

²⁵⁰ Transcript: Mayor de Blasio Signs New Law Lowering New York City's Default Speed Limit to 25 MPH (Oct. 27, 2014), <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-mpm> (announcing that from November 7, 2014, onward, the speed limit on all streets in New York City will be 25 miles per hour unless otherwise posted); Jim Gorzelany, *The World's Most Traffic-Congested Cities*, FORBES (Apr. 25, 2013), <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 13 miles per hour).

counterparts.²⁵¹ Yet even if driverless vehicles are safer than other methods of transportation, they will still get into accidents.²⁵² When this happens, questions will arise regarding who should have to bear the costs of these accidents.

There exists a well-established body of law that prescribes the legal liabilities of manufacturers and operators of conventional automobiles when these devices injure people or property. This section reviews these rules and considers how they may apply to driverless vehicles.²⁵³

These civil liability projections involve substantial speculation. It is far from certain that the laws of tomorrow will be the same as those of today. Also, driverless technologies (or the market for these devices) may or may not evolve in the manner presently forecast. These and other contingencies make it difficult to pinpoint how liability rules and driverless vehicles will intersect. Nevertheless, as discussed earlier in this report certain patterns tend to recur when new technologies lead to perceived risks of personal injuries. These trends, as mapped against the current law and the anticipated trajectory of driverless vehicles' development and diffusion, afford a basis for probabilistic, as opposed to definite, forecasts.

A. Basic Principles

According to NHTSA, an estimated 5,615,000 police-reported motor vehicle traffic crashes occurred in 2012.²⁵⁴ Although only a small percentage of these crashes generated lawsuits, automobile accidents produce more personal injury lawsuits than do any

²⁵¹ See, e.g., NORMAN GEL GEDDES, MAGIC MOTORWAYS 56–57 (1940) (discussing the safety features anticipated to appear in the automobiles of 1960); Martin Mann, *The Car That Drives Itself*, POPULAR SCIENCE, May 1958, at 75.

²⁵² Indeed, in May 2015 Google acknowledged that its self-driving vehicles had been involved in 11 minor accidents. These mishaps were attributed to human errors, not the self-driving capabilities of these devices. Justin Pritchard, *Google Acknowledges 11 Accidents with Its Self-Driving Cars*, SAN JOSE MERCURY News (May 10, 2015), http://www.mercurynews.com/california/ci_28091208/business-special-reports.

²⁵³ Several commentators already have considered whether and to what extent these principles will apply to the makers and users of driverless vehicles. E.g., RAND REPORT, *supra* note 181, at 111–34; F. Patrick Hubbard, “Sophisticated Robots”: *Balancing Liability, Regulation, and Innovation*, 66 FLA. L. REV. 1803 (2014); Gary E. Marchant & Rachel A. Lindor, *The Coming Collision Between Autonomous Vehicles and the Liability System*, 52 SANTA CLARA L. REV. 1321 (2012); John Villasenor, *Products Liability and Driverless Cars: Issues and Guiding Principles for Legislation*, BROOKINGS (Apr. 24, 2014), <http://www.brookings.edu/research/papers/2014/04/products-liability-driverless-cars-villasenor>.

²⁵⁴ NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, TRAFFIC SAFETY FACTS: RESEARCH NOTE 2012 MOTOR VEHICLE CRASHES: OVERVIEW, DOT HS 811 586, 4 (2013).

other type of accident.²⁵⁵

When automobile accidents lead to personal injury and property-damage lawsuits, these cases typically involve application of one or more theories of recovery in tort. Lawsuits against the drivers of automobiles, or against other persons on or about the road, typically sound in a negligence theory of liability. Manufacturers, distributors, and sellers of a vehicle also may be held liable for their negligence, but more often are alleged to have produced a “defective” product under one or more theories of “strict products liability.” The text below summarizes these various avenues of recovery.

1. Negligence

Negligence represents the most fundamental and pervasive theory of liability for accidents. A plaintiff suing for negligence must plead and prove a series of “essential elements” in order to recover damages.²⁵⁶ Specifically, the plaintiff must establish that:

- The defendant owed the plaintiff a duty of care, with the standard normally being set at “reasonable” or “ordinary” care;
- The defendant failed to exercise the required care, an element often referred to as “breach”;
- The plaintiff’s harm was caused by the defendant’s breach of its duty of care (i.e., by the defendant’s negligence)—in other words, had the defendant acted with reasonable care, the harm would not have occurred (an element often referred to as “cause in fact,” or “but-for causation”).²⁵⁷

²⁵⁵ THOMAS H. COHEN, TORT BENCH AND JURY TRIALS IN STATE COURTS, 2005 1, U.S. Department of Justice, Bureau of Justice Statistics (Nov. 6, 2009). See also DEBORAH R. HENSLER, M. SUSAN MARQUIS, ALLAN F. ABRAHAMSE, SANDRA H. BERRY, PATRICIA A. EBENER, ELIZABETH G. LEWIS, E. ALLAN LIND, ROBERT J. MACCOUN, WILLARD G. MANNING, JEANNETTE A. ROGOWSKI & MARY E. VAINA, COMPENSATION FOR ACCIDENTAL INJURIES IN THE UNITED STATES 122–23 (1991) (describing the linkage between automobile accidents and “claiming” behavior by injured parties).

²⁵⁶ DAN B. DOBBS, THE LAW OF TORTS § 125 (2d ed. 2011).

²⁵⁷ This inquiry normally requires a counterfactual in which all other circumstances are held constant, except that the allegedly negligent party acted with the requisite care. If the same harm would have transpired anyway notwithstanding these changed circumstances, the requisite causal connection does not exist. RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL AND EMOTIONAL HARM § 26, cmt. (2010). In limited circumstances, a party’s obligation to prove but-for causation (also sometimes referred to as “cause in fact”) will be relaxed. This situation sometimes arises when defendants whose negligence already has been established occupy a superior position, relative to the plaintiff, to prove that their breach of a duty did not contribute to the plaintiff’s injuries. In chain collisions involving *seariatim* accidents among automobiles, for example, some courts shift the burden to multiple negligent defendants to establish that their negligence was not the cause of all or part of the injuries incurred by a plaintiff buffeted by multiple impacts. E.g., *Fugere v. Pierce*, 5 Wash. App. 592, 597, 490 P.2d 132, 135–36 (Wash. App. 1971).

- The defendant's negligence also must represent a "proximate cause" of the plaintiff's harm, meaning that a reasonable person in the defendant's position at the time of his or her claimed negligence would have foreseen that their negligent behavior could lead to harm of the general sort suffered by the plaintiff;²⁵⁸ and
- Damages.²⁵⁹

The duty element of a negligence claim is a "matter of law," meaning that judges, rather than juries, ordinarily ascertain whether a defendant owed a plaintiff a duty.²⁶⁰ With conventional automobile accidents, the existence of a duty is only rarely a disputed issue.²⁶¹ Matters that are contested more often concern whether the defendant breached his or her duty of reasonable care, whether this breach caused the plaintiff's injuries, the extent of the plaintiff's damages, and whether these damages are wholly or in part due to the plaintiff's own negligence. The last of these matters represents a defense commonly referred to as "comparative negligence" or "comparative fault."²⁶² Unlike questions of duty, these issues are left to juries to decide, unless the parties have stipulated to a trial before a judge, or a judge determines that given the facts involved, all reasonable juries would have to agree how an issue should be decided.

In evaluating the viability of a negligence claim resulting from a vehicle accident, parties, attorneys, and judges benefit from a robust body of case law that has accumulated over the past 115 years.²⁶³ Opinions issued by judges in earlier cases and records of jury verdicts help lawsuit participants anticipate the resolution of disputes. Judicial opinions, in particular,

²⁵⁸ Proximate causation conventionally has been described in terms of whether a type of harm was foreseeable at the time of the negligent act or omission, or as an inquiry into whether an actor's negligence was a "substantial factor" in bringing about the claimed harm. RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL AND EMOTIONAL HARM, *supra* note 257, at § 29 cmts. a, e. More recently, a formulation has emerged whereby proximate cause relates to the "scope" of the enhanced risk created by an actor's negligent behavior. The RESTATEMENT (THIRD) OF TORTS: PHYSICAL AND EMOTIONAL HARM, an advocate of this approach, provides that "[a]n actor's liability is limited to those harms that result from the risks that made the actor's conduct tortious." *Id.* § 29.

²⁵⁹ DOBBS, *supra* note 256, at § 124.

²⁶⁰ RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYSICAL AND EMOTIONAL HARM, *supra* note 257, § 7 cmt. b.

²⁶¹ 60A CORPUS JURIS SECUNDUM MOTOR VEHICLES § 582 (2015) ("The operator of a motor vehicle has a duty to exercise reasonable or ordinary care for the safety of others while operating his vehicle.")

²⁶² DOBBS, *supra* note 256, at § 220.

²⁶³ The first published decision in a tort lawsuit involving an automobile was *Mason v. West*, 31 Misc. 583, 65 N.Y.S. 651 (C.C.N.Y. 1900), *rev'd*, 70 N.Y.S. 478 (N.Y.A.D. 1901).

provide guidance in the application of various rules associated with the presentation of vehicle accident claims that sound in negligence. Such topics include whether a statute, regulation, or ordinance will flesh out the generic standard of reasonable care, under a doctrine known as *negligence per se*,²⁶⁴ and whether circumstantial evidence permits a jury to infer a party's negligence, under a doctrine known as *res ipsa loquitur*.²⁶⁵ The predictability of the outcomes in many automobile-accident cases has led to the "routinization" of a substantial segment of legal practice in this field. High-volume "settlement mills" resolve many of these matters, especially those that involve only modest damages.²⁶⁶

2. Strict Products Liability

Negligence law also applies to the manufacturers and sellers of automobiles.²⁶⁷ Furthermore, in the vast majority of states these parties also may be sued under an alternative theory of tort liability. This form of liability does not rest squarely on notions of "fault," as does negligence. Instead, this approach holds product manufacturers and other defendants closely involved in a product's chain of distribution and sale liable without a showing of fault for "defects" in the products they make, distribute, or sell.²⁶⁸

²⁶⁴ RESTATEMENT (THIRD) OF TORTS: PHYSICAL AND EMOTIONAL HARM, *supra* note 257, § 14 ("An actor is negligent if, without excuse, the actor violates a statute that is designed to protect against the type of accident the actor's conduct causes, and if the accident victim is within the class of persons the statute is designed to protect.").

²⁶⁵ *Id.* § 17 ("The factfinder may infer that the defendant has been negligent when the accident causing the plaintiff's harm is a type of accident that ordinarily happens as a result of the negligence of a class of actors of which the defendant is the relevant member.")

²⁶⁶ Nora Freeman Engstrom, *Run-of-the-Mill Justice*, 22 GEO. J. LEG. ETHICS 1485, 1500 (2009) (discussing the emergence of "settlement mills" for soft-tissue automobile accident claims).

²⁶⁷ DAVID G. OWEN, PRODUCTS LIABILITY LAW §§ 2.1–2.6 (2008).

²⁶⁸ Warranty law also provides a means for purchasers of goods to recover against the seller, regardless of negligence, when the purchased products proved defective. Today, the few states that have not adopted strict products liability in tort tend to recognize similar rights of redress cast as warranty protections. Graham, *supra* note 124, at 620. In jurisdictions that recognize strict products liability claims, a cause of action alleging a breach of a warranty may provide an additional basis for recovery. The most important warranty associated with the sale of goods by merchants is the implied warranty of merchantability. Under Section 2-314 of the Uniform Commercial Code, "a warranty that the goods shall be merchantable is implied in a contract for their sale if the seller is a merchant with respect to goods of that kind." U.C.C. § 2-314. To be "merchantable," fungible goods must be "of fair average quality" and "fit for the ordinary purposes for which such goods are used." *Id.*

There exist three such forms of “strict products liability,” which are distinguished from one another by the nature of the defect that the product is alleged to contain:

- *Manufacturing Defects.* A product contains a “manufacturing defect” when it “departs from its intended design even though all possible care was exercised in the preparation and marketing of the product.”²⁶⁹ This sort of defect applies to products that are “physically flawed, damaged, or incorrectly assembled,”²⁷⁰ such as a soda bottle cast with glass less thick than the manufacturer specified, making the bottle prone to break. The prevalence of products with this sort of defect in the 1940s and 1950s helped inspire the trend toward strict products liability.²⁷¹ Due to modern quality-control measures, however, claims that allege manufacturing defects are now few and far between.²⁷²

- *Design Defects.* By contrast, design defect claims, once rare, are now relatively common.²⁷³ There exist two approaches toward recognizing a defect in a product’s intended design. One, known as the “consumer expectations” or “consumer contemplation” standard, regards a product’s design as defective when it fails to perform as safely as an ordinary consumer would expect under the circumstances presented.²⁷⁴ An alternative approach is sometimes referred to as the “risk-utility” definition of a design defect. Per one leading authority that endorses this view of a design defect, a product

is defective in design when the foreseeable risks of harm posed by the product could have been reduced or avoided by the adoption of a reasonable alternative design by the seller or other distributor, or a predecessor in the commercial chain of distribution, and the omission of the alternative design renders the product not reasonably safe.²⁷⁵

Today, few jurisdictions apply only the “consumer expectations” definition of a design defect.²⁷⁶ Most states have adopted some form of the risk-utility test as the principal means for ascertaining a design defect. Nevertheless, in evaluating whether a particular product’s design is “not reasonably safe,”

²⁶⁹ 23 C.F.R. § 636.109.

²⁷⁰ *Id.* § 2 cmt. c.

²⁷¹ Graham, *supra* note 124, at 600–13.

²⁷² Aaron D. Twerski, *Chasing the Illusory Pot of Gold at the End of the Rainbow: Negligence and Strict Liability in Design Defect Litigation*, 90 MARQ. L. REV. 7, 18 (2006) (“Manufacturing defects are rare events.”)

²⁷³ JANE STAPLETON, *PRODUCT LIABILITY* 30 (1994).

²⁷⁴ Mikolajczyk v. Ford Motor Co., 231 Ill. 2d 516, 526–27, 901 N.E.2d 329, 336 (2008).

²⁷⁵ RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY, *supra* note 269, § 2.

²⁷⁶ *Id.* § 2 cmt. d.

these jurisdictions commonly encourage the consideration of a wide range of factors that may include the safety expectations of consumers.²⁷⁷ Other jurisdictions utilize a hybrid approach that more directly implicates both the consumer expectations standard and a risk-utility formulation.²⁷⁸

- *Warning Defects.* Third and finally, a product is regarded as defective when a failure to provide sufficient instructions or warnings renders the product “not reasonably safe” in light of the “foreseeable risks of harm posed by the product.”²⁷⁹ This standard, with its emphasis upon the need for reasonable notice of foreseeable risks, deviates only modestly from a negligence rule.

Many judicial opinions have elaborated how these principles apply to automobiles.²⁸⁰ It is today well accepted that automobiles must be designed in a manner that makes them reasonably safe even in the event of an accident—in other words, they must be “crashworthy.”²⁸¹ It is also generally accepted that a plaintiff’s negligence can represent a full or partial defense in a products lawsuit.²⁸² However, there exists no similar consensus about other issues associated with products liability cases, such as whether a plaintiff will be regarded as having breached his or her duty of exercising reasonable care for their own safety by failing to utilize a seat belt.²⁸³

Personal injury lawsuits against manufacturers and sellers of driverless vehicles—whether framed in negligence, strict liability, or other theories—likely will draw to some degree from decisions in prior cases involving products such as conventional vehicles and their components, GPS devices,²⁸⁴

²⁷⁷ *Id.*, § 2 cmt. f. See also John W. Wade, *On the Nature of Strict Tort Liability for Products*, 44 Miss. L.J. 825, 837–38 (1973) (relating factors relevant to the design-defect inquiry).

²⁷⁸ See, e.g., Soule v. Gen. Motors Corp., 8 Cal. 4th 548, 566–68, 882 P. 2d 298, 307–309 (1994); Mikolajczyk, 231 Ill. 2d at 555–57 (Ill. 2008).

²⁷⁹ RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY *supra* note 269, § 2.

²⁸⁰ This type of litigation is so common as to merit a full chapter in the leading single-volume products liability treatise. OWEN, *supra* note 267, §§ 17.1–17.5.

²⁸¹ RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY, *supra* note 269, § 16 & cmt. a.

²⁸² *Id.*, § 17 & cmt. a.

²⁸³ DOBBS, *supra* note 256, § 231.

²⁸⁴ E.g., American Winds Flight Acad. v. Garmin Intern., 2010 U.S. Dist. LEXIS 97651 (N.D. Ohio Sept. 17, 2010) (holding that the manufacturer of a GPS device was not liable for the death of a pilot in an airplane equipped with the device, on grounds including the open and obvious nature of the danger associated with exclusive reliance upon the device).

autopilot functions on airplanes,²⁸⁵ and aeronautical charts.²⁸⁶ As to certain issues, these cases have produced a robust body of seemingly pertinent case law; as to other topics, there are fewer decisions on point. Furthermore, the risks and benefits of driverless vehicles may be sufficiently distinctive that these decisions may not provide useful references in all circumstances.

3. Limitation or Preemption of Tort Liability

Critics of the tort system sometimes express concerns that the application of common-law tort principles through the courts can involve excessive costs, insufficient or poorly allocated benefits, and the recognition of conflicting or suboptimal standards of conduct. An additional fear is that even the mere threat of tort liability potentially can frustrate the development and diffusion of socially beneficial technologies. These concerns have prompted efforts to avoid or limit conventional tort law in particular contexts:

- *No-Fault Insurance Laws.* In the 1960s and 1970s, many states enacted “no-fault” automobile insurance regimes.²⁸⁷ Under these laws, claims that allege only minor property damage or modest personal injuries bypass the tort system altogether, and are instead compensated by first-party insurance on a “no-fault” basis.²⁸⁸ It was hoped that “no-fault” regimes would result in more compensation for accident victims at a cost savings relative to conventional systems that depend more heavily upon courtroom litigation for recovery.²⁸⁹ After a promising start, the no-fault movement stalled in the mid-1970s due to circumstances such as opposition among plaintiffs’ lawyers, disappointing early results that failed to meet the expectations of no-fault advocates, and the closing of a “policy window” conducive to the enactment of no-fault schemes.²⁹⁰ These dynamics have led a few states to repeal the no-fault statutes they had enacted.²⁹¹

²⁸⁵ Brouse v. United States, 83 F. Supp. 373, 374 (N.D. Ohio 1949). See also Dylan LeValley, *Autonomous Vehicle Liability—Application of Common Carrier Liability*, 36 SEATTLE UNIV. L. REV. *supra* 5, 9–10 (2013) (critiquing the analogy between autonomous vehicles and autopilot functions).

²⁸⁶ See generally David L. Abney, *Liability for Defective Aeronautical Charts*, 52 J. AIR L. & COM. 323 (1986).

²⁸⁷ JAMES M. ANDERSON, PAUL HEATON & STEPHEN J. CARROLL, THE U.S. EXPERIENCE WITH NO-FAULT AUTOMOBILE INSURANCE 35–44 (2010). Engstrom, *supra* note 103, at 303.

²⁸⁸ Engstrom, *supra* note 103, at 320–22.

²⁸⁹ See generally ROBERT E. KEETON & JEFFREY O’CONNELL, BASIC PROTECTION FOR THE TRAFFIC VICTIM (1965).

²⁹⁰ Engstrom, *supra* note 103, at 328–79.

²⁹¹ *Id.* at 306.

- *Liability Caps.* The federal government and many states have placed caps on the damages that claimants can recover in certain contexts.²⁹² One type of cap limits the damages that can be received for a particular type of harm in a class of accidents or lawsuits, such as the ceilings that some states have placed on noneconomic damages (such as pain and suffering) in medical malpractice cases.²⁹³

- *Alternative Forums.* Statutes also can channel claims toward forums other than conventional courts. For example, in response to concerns that liability pressures were depleting the supply of childhood vaccines, Congress enacted the National Childhood Vaccine Injury Act of 1986.²⁹⁴ This law directs personal injury claims associated with the administration of a listed vaccine toward a special federal forum, in which cases are heard by special masters, rather than juries.²⁹⁵ These masters can award damages (funded by an excise tax on vaccines), but the pain and suffering damages that can be awarded for successful claims are capped at \$250,000.²⁹⁶

- *Preemption by Statute:* Congress and state legislatures can eliminate tort liability by preempting these claims.²⁹⁷ One rationale for preemption involves the protection of an emerging industry from the threat of future litigation. In this spirit, the Biomaterials Access Assurance Act of 1998 conferred broad immunity upon the suppliers of biomaterials for injuries associated with implants that incorporated these biomaterials, but were manufactured by other parties.²⁹⁸ Likewise, by providing that “[n]o provider or user of an interactive computer service shall be treated as the publisher or speaker of any information provided by another information content provider,” Section 230 of the

²⁹² A survey of state damages caps can be found at the American Tort Reform Association’s Web site, <http://www.atra.org/legislation>. Though these caps appear more often in state law, federal law incorporates a few such provisions, e.g., that found in the Oil Pollution Act of 1990, Pub. L. No. 101-380, § 1004, 104 Stat. 84, Aug. 18, 1990 (capping certain forms of civil liability for oil spills).

²⁹³ CAL. CIV. CODE § 3333.2 (West 1997).

²⁹⁴ National Childhood Vaccine Injury Act of 1986, Pub. L. No. 99-660, 100 Stat. 3755 (codified at 42 U.S.C. §§ 300aa-1 to -34 (2012)).

²⁹⁵ 42 U.S.C. §§ 300aa-10 to -16.

²⁹⁶ *Id.* §§ 300aa-15.

²⁹⁷ E.g., Bruesewitz v. Wyeth LLC, 562 U.S. 223, 243, 131 S. Ct. 1068, 1082, 179 L. Ed. 2d 1, 17 (2011); Riegel v. Medtronic, Inc., 552 U.S. 312, 330, 128 S. Ct. 999, 1011, 169 L. Ed. 2d 892, 906 (2006); Geier v. American Honda Motor Co., 529 U.S. 861, 886, 120 S. Ct. 1913, 1928, 146 L. Ed. 2d 914, 935 (2000).

²⁹⁸ Biomaterials Access Assurance Act of 1998, Pub. L. No. 105-230, 112 Stat. 1519, 1525.

Communications Decency Act of 1996²⁹⁹ greatly limited plaintiffs' ability to recover against the operators of Internet websites for content generated by third parties.

- *Preemption by Regulation:* Administrative regulations enacted under the authority conferred by statute also may preempt tort remedies. In *Geier v. American Honda Motor Co.*,³⁰⁰ for example, the United States Supreme Court held that air bag standards promulgated by NHTSA preempted a plaintiff's claim that her automobile was defective for failing to incorporate a driver's-side air bag.³⁰¹ The *Geier* Court acknowledged that the statute under which the agency had promulgated the regulation did not expressly preempt tort remedies.³⁰² The plaintiff's lawsuit was nevertheless barred, the Court held, because it sought to achieve through litigation a goal (universal incorporation of air bags) that conflicted with the pertinent safety standard's perceived objective of encouraging a variety of passive restraint systems within automobiles.³⁰³

This list does not exhaust the ways in which legislatures or administrative agencies can limit tort liability. Laws also may alter the procedures associated with tort claims to make recovery more difficult,³⁰⁴ provide product manufacturers with an affirmative defense such as a statute of repose,³⁰⁵ or eliminate or preclude certain causes of action.³⁰⁶ In certain instances, however, state laws that limit plaintiffs' remedies have been struck down as violating the enacting state's constitution.³⁰⁷

²⁹⁹ Communications Decency Act of 1996, Pub. L. No. 104-104, § 509, 110 Stat. 133, 137–39 (Title V, Telecommunications Act of 1996, Pub. L. No. 104-104, 110 Stat. 56).

³⁰⁰ 529 U.S. 861, 120 S. Ct. 1913, 146 L. Ed. 2d 914 (2000).

³⁰¹ *Id.* at 865.

³⁰² *Id.* at 868.

³⁰³ *Id.* at 886.

³⁰⁴ COLO. REV. STAT. ANN. § 13-25-127(2) (West 2014) (permitting an award of exemplary damages only on the presentation of proof beyond a reasonable doubt that the tort was attended by fraud, malice, or willful and wanton conduct).

³⁰⁵ E.g., TEX. CIV. PRAC. & REM. CODE ANN. § 16.012(b) (West 2015) (creating a 15-year statute of repose, running from the time of sale, in products liability actions).

³⁰⁶ See, e.g., Bonnie Hershberger, *Supersized America: Are Lawsuits the Right Remedy?*, 4 J. FOOD L. & POL'Y 71, 82 (2008) (discussing the enactment of laws addressing “obesity lawsuits” in approximately half of the states).

³⁰⁷ E.g., *Watts v. Lester E. Cox Medical Centers*, 376 S.W.3d 633, 636 (Mo. 2012) (holding that a state law capping non-economic damages in medical malpractice cases violated the right to a jury trial conferred by the Missouri state constitution).

4. Additional Considerations

Tort law does not necessarily apply to new technologies in an easily predictable or wholly rational manner. Instead, there exist several possible sources of contingency in the application of even well-established rules to a new device. This report touched upon several of these dynamics in its discussion of innovations of the past: immature claim consciousness;³⁰⁸ inadequate, skewed, or evolving risk assessments;³⁰⁹ absent or off-point baseline analogical references;³¹⁰ idiosyncratic events; and path dependence in the law.³¹¹

B. Application

The text below will discuss other analysts' predictions regarding the civil liability prospects of driverless vehicles, before offering a forecast of its own.

1. Other Analyses of Liability for Accidents

Existing analyses of how tort liability may adhere to the manufacture and use of driverless vehicles tend to agree on certain matters. They have reached the shared conclusion that a proliferation of driverless vehicles eventually will lead to an “upward” shift in the locus of civil liability for everyday accidents, away from drivers and toward the manufacturers of these devices.³¹² This movement, it is believed, will necessitate greater reliance upon products liability law as a rule of decision in vehicle accident cases.³¹³ Within this area of the law, design defect and warning defect claims are expected to be more common than manufacturing defect claims.³¹⁴

³⁰⁸ See William L.F. Felstiner, Richard L. Abel & Austin Sarat, *The Emergence and Transformation of Disputes: Naming, Blaming, Claiming...,* 15 LAW & SOC. REV. 631 (1980); Graham, *Of Frightened Horses and Autonomous Vehicles: Tort Law and Its Assimilation of Innovations*, *supra* note 92, at 1266; Michael L. Rustad & Thomas H. Koenig, *Cybertorts and Legal Lag: An Empirical Analysis*, 13 SO. CA. INTERDISCIPLINARY L.J. 77, 77–78 (2004) (discussing the concept of “legal lag” as applied to tort law and new technologies).

³⁰⁹ See RACHEL MAINES, *ASBESTOS AND FIRE: TECHNOLOGICAL TRADE-OFFS AND THE BODY AT RISK* (2005) (discussing the shifts that have occurred in the risk perceptions that have surrounded asbestos); Graham, *Of Frightened Horses and Autonomous Vehicles: Tort Law and Its Assimilation of Innovations*, *supra* note 92, at 1256–66; Peter Huber, *Safety and the Second Best: The Hazards of Public Risk Management in the Courts*, 85 COLUM. L. REV. 277, 319 (1985).

³¹⁰ Graham, *Of Frightened Horses and Autonomous Vehicles: Tort Law and Its Assimilation of Innovations*, *supra* note 92, at 1252–56; Mandel, *supra* note 175, at 553–57.

³¹¹ See Hathaway, *supra* note 174.

³¹² RAND REPORT, *supra* note 181, at xxii; Marchant & Lindor, *supra* note 253, at 1323.

³¹³ Julie Goodrich, *Driving Miss Daisy: An Autonomous Chauffeur System*, 51 HOUSTON L. REV. 265, 280–81 (2013).

³¹⁴ Marchant & Lindor, *supra* note 253, at 1323.

On other topics, existing predictions part ways. Some, although not all, of these analyses have expressed concerns that judges and juries will overestimate the risks associated with driverless vehicles and fail to fully take into account the safety-enhancing characteristics of these devices.³¹⁵ Of particular concern is the possibility that juries will find manufacturers of driverless vehicles liable for an aspect of a vehicle's performance (such as a decision to swerve left when confronted by a particular scenario) that is on balance preferable to the known alternatives, but nevertheless caused the particular plaintiff in the case at hand to suffer an injury. These worries have led some commentators to ask whether it is or will become good policy to preempt or limit the tort liability of the manufacturers of driverless vehicles.³¹⁶ Other observers disagree with this prediction and prescription. Those who take the latter view anticipate that the common law will prove capable of fair application to driverless vehicles in any personal injury lawsuits that may arise, whereas the preemption of tort liability would eliminate an incentive for the manufacturers of driverless vehicles to improve their products' safety.³¹⁷

Presently, all of these predictions and conclusions—regardless of whether they agree or conflict—seem reasonable, but hardly indisputable. It is difficult enough to forecast how the law will apply to today's technologies. The catalogue of contingencies associated with driverless vehicles therefore allows only rough predictions. In addition to the possibility of changes in the underlying law, it is unclear whether and to what extent:

- Driverless vehicles will be primarily self-directed, or will rely on V2V or V2I communications to direct their movement;
- The software associated with driverless vehicles will be marketed as, and generally understood to represent, a product distinct from a vehicle's physical hardware;
- Driverless technologies will evolve in the manner and sequence presently anticipated;
- Driverless vehicles initially will be available only to limited audiences, or be deployed only in particular contexts (such as providing transportation for hire within urban areas); and
- Conspicuous accidents or other adverse events will occur that may frustrate or delay the use and acceptance of these devices.

³¹⁵ *Id.* at 1334–35.

³¹⁶ RAND REPORT, *supra* note 181, at 118; Goodrich, *supra* note 313, at 292–93. See also *id.* at 132 (“[M]anufacturer liability is expected to increase, and this may lead to inefficient delays in the adoption of these technologies.”)

³¹⁷ *E.g.*, Villasenor, *supra* note 253.

Each of these uncertainties could have a profound effect on the civil liability rules associated with driverless vehicles. Greater reliance on a V2I system than is presently anticipated, for instance, likely would necessitate substantial government engagement in the development of the necessary infrastructure, which in turn could create a larger aperture for negligence claims against state and local authorities (and implication of the various immunities that can apply to government decision making) than might otherwise exist.

These contingencies mean that any predictions regarding the liability prospects of driverless vehicles must be both general and probabilistic, state key underlying assumptions, and appreciate the temporal dimension of tort law and practice. The forecast that follows assumes the gradual emergence, over the next several years, of driverless vehicles with incrementally evolving capabilities up to and including Level 4 NHTSA functionality. It further assumes that advanced driverless vehicles will be mass-marketed to consumers and eventually will garner a significant share of the market for new vehicles, but share the road with both conventional vehicles and vehicles with automated capabilities for at least the next half-century.

2. *Liability for Accidents: A Staged Forecast*

These assumptions lead to the following plausible, if not unavoidable, projections. The types of personal injury cases associated with driverless vehicles likely will evolve over time. Claims that allege user negligence will predominate at first, but eventually will fall off substantially as driverless vehicles and their users both grow more common and competent. These claims against users will be replaced, to a degree, by claims that allege defects in driverless vehicles (the “upward” shift spoken of by other commentators), although these claims will not be as common as negligence lawsuits brought against drivers are today, due to the enhanced safety profile of these devices.

Most early claims against manufacturers of driverless vehicles likely will resemble those lodged against the makers of conventional vehicles, attacking matters such as a perceived lack of design “crashworthiness.” There may be a lag before a substantial number of sophisticated defect claims that specifically attack driverless features and functions appear. Any early cases, however, likely will prove important in directing the future path of the law. Significantly, in the long run the total number of personal injury lawsuits involving vehicles should

³¹⁸ See generally BOSTON CONSULTING GROUP REPORT, *supra* note 188 (offering similar predictions regarding the diffusion of autonomous vehicles).

drop precipitously, due to the ability of sophisticated driverless vehicles to avoid or reduce the severity of accidents that would befall human drivers.

The text below divides this scenario into three stages, each of which signifies a different phase in the maturation of personal injury litigation involving driverless vehicles.

a. Stage One: Early Litigation—The immediate future likely will witness only a modest volume of tort litigation owing to the distinctive qualities of driverless vehicles. If these cases emerge, most will address basic issues associated with the use of driverless vehicles, such as the proper spheres allocated to human direction and automatic control of these devices, how users and manufacturers should manage the transitions between these modalities, and core principles regarding interactions between driverless vehicles on the one hand and conventional automobiles and other highway users on the other.

Several dynamics may contribute to a lag in cases involving driverless vehicles during this span. These constraints include the limited number of driverless vehicles on the highways; advancing but still immature expectations regarding the rights and responsibilities of the manufacturers and operators of driverless vehicles (and others who come into contact with these devices); difficulties that early adopters of these devices may experience in recovering for their injuries, should a sense prevail that the devices are to some degree still experimental and choices to use them assume significant risk; statutes and regulations that restrict the use of driverless vehicles and technologies incorporated within these vehicles; and potential marketing and sales strategies associated with the first wave of driverless vehicles, such as a practice of channeling sales toward institutional customers who stipulate to operate these devices only in a manner whereby accidents are particularly unlikely to occur.³¹⁹

The rarity of cases involving driverless vehicles, however, will make any cases that are litigated especially significant; indeed, perhaps unrealistically important. During this early phase, due to path dependence and the likely notoriety of initial judicial decisions that concern this new technology, whatever tort litigation does occur may have substantial impact on the development of the law pertaining to these vehicles. For example, if early case outcomes suggest that generic tort principles do not properly account for the unique risks and benefits of driverless vehicles, pressure will build for the

³¹⁹ See Bryant Walker Smith, *Proximity-Driven Liability*, 102 GEO. L.J. 1777, 1815–18 (2014) (considering how entities that sell driverless vehicles or services associated with these devices could manage their risk profile through alternative sales and service strategies).

reevaluation and possible alteration of these rules whether through federal preemption or otherwise.

To the extent that litigation concerning driverless vehicles does arise during this span, the immaturity of the technology and plaintiffs' evolving "claim consciousness" suggests a bias toward lawsuits that attack 1) decisions made by the drivers of automated vehicles with driverless capacities, and in particular, decisions associated with the engagement and maintenance of driverless functionalities; 2) an alleged failure to provide sufficient warnings regarding risks associated with these devices, particularly vis-à-vis the utilization of driverless capabilities (as opposed to "hands-on" driving); and 3) alleged defects in a vehicle's sensors, actuators, and other hardware, as opposed to defect claims that attack flaws in the software that translates information derived from sensors into driving instructions.

With regard to the first of these categories of potential claims, early adopters of driverless vehicles may be subject to allegations that they failed to exercise the required care vis-à-vis one or more novel attributes of these devices. The first wave of automated vehicles with driverless functionalities will be capable of driverless operation only in certain areas, and may be precluded by law or design from being operated in driverless mode elsewhere. This limitation raises the possibility of litigation in which injured plaintiffs will ascribe their injuries to an operator's assertedly negligent decision to utilize a driverless vehicle in an area where, or at a time when, it either was not authorized for use, or when or where it may have been unreasonably unsafe to engage an automated vehicle's driverless functions.³²⁰ These claims may point to a violation of a pertinent time, place, or manner statute, regulation, or ordinance as bespeaking negligence, or may seek to create novel common-law "rules of the road" that will come to govern interactions between driverless vehicles and either conventional vehicles or pedestrians.

The improper engagement of driverless features in certain areas or zones also may generate warning-defect claims against manufacturers, as well as related design-defect claims that condemn, for example, the absence of an automatic transfer of the driving function to active human direction under certain circumstances. Manufacturers predictably will seek to avoid the first type of claim by requiring that prospective purchasers undergo extensive training and certify their awareness of various hazards and limitations associated with the operation of these vehicles. The second type of claim may require litigation to ascertain the manufacturer's design responsibilities.

³²⁰ See RAND REPORT, *supra* note 181, at 132 (discussing the "weak spot" at the driver-vehicle interface).

Other design-defect claims also may emerge. While basic driverless technologies are still developing, the risk-utility profiles associated with alternative design choices may be difficult to pinpoint. Some design decisions made by manufacturers may be susceptible to scrutiny sooner than others, however. Sensor technology, for example, is (or soon will be) at a point where different designs can be meaningfully compared with one another, as would be required for recovery for a design defect in risk-utility jurisdictions.³²¹

Difficulties in intelligently critiquing programming choices may inhibit nuanced design-defect lawsuits involving vehicle software, at least for a time. Software may produce early and easy product-defect litigation where it leads to palpably improvident outcomes—such as a vehicle turning abruptly and unexpectedly into oncoming traffic, running a red light, or crossing over a sidewalk when making a turn—in which case a defect of some sort will be difficult to deny.³²² In such cases, the presence of a defect likely will be ascertained simply by assessing whether a vehicle's actions substantially deviated from customary safe driving practices utilized by the closest substitute—human drivers under similar conditions.

That said, certain features of driverless vehicles may accelerate the normally gradual process through which plaintiffs develop claim consciousness and their counsel develop the ability to identify and attack a design defect. Highway users already are conditioned to regard an automobile accident as the potential basis for a “claim” of some sort.³²³ Furthermore, information collected or relayed by driverless vehicles may shorten the feedback loop through which data regarding a product’s dangerous qualities is gathered and translated into possible improvements. Even the issuance of a software “patch” for a driverless vehicle could greatly simplify a plaintiff’s lawyer’s burden of locating and proving a product defect,

³²¹ BOSTON CONSULTING GROUP REPORT, *supra* note 188, at 13.

³²² Per the RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY *supra* note 269:

It may be inferred that the harm sustained by the plaintiff was caused by a product defect existing at the time of sale or distribution, without proof of a specific defect, when the incident that harmed the plaintiff:

(a) was of a kind that ordinarily occurs as a result of product defect; and

(b) was not, in the particular case, solely the result of causes other than product defect existing at the time of sale or distribution.

Id., § 3.

³²³ HENSLER, *supra* note 255, at 122–23.

especially in jurisdictions that permit the introduction of such remedial measures in court.³²⁴

As suggested before, depending upon their number, cost, and outcome, early design and warning defect cases may cause manufacturers to press for liability-lessening measures. One such option would involve the creation of “safe harbors” through legislation or regulation, whereby the satisfaction of a safety standard would provide an affirmative defense to liability. Alternatively, legislatures could preempt state tort liability standards for driverless vehicles—either altogether, as to a particular type of defendant, or for particular types of accidents. Whether and to what extent these efforts will prove successful will depend upon a constellation of factors, including the perceived safety benefits of driverless vehicles, the perception that liability may or may not unduly deter their development and deployment, and the persuasiveness of affected stakeholders.

In summary, the first phase of litigation over driverless vehicles is expected to involve relatively few cases. Most litigation against the makers of driverless vehicles during this span probably will not concentrate upon driverless capabilities at all, but instead will seem almost identical to claims presently lodged against the makers of conventional automobiles. As for claims against the users of driverless devices, plaintiffs may try to restyle existing theories of negligence commonly directed against the drivers of conventional vehicles, for example, by attacking the users of driverless vehicles as insufficiently attentive toward circumstances that arguably required “hands-on” driving. This sort of claim may lead to the integration of manufacturers into the litigation mix, under a failure-to-warn theory. It also is possible that even in this early phase of litigation, manufacturers may become enmeshed in cases that challenge specific design choices made regarding technologies such as sensors, and, conceivably, programming decisions regarding how the vehicle should respond to stimuli. Depending upon their number and cost, these lawsuits may cause manufacturers to press for laws or regulations that will provide affirmative defenses to liability, or outright preemption of state tort liability.

b. Stage Two: The Maturation of Driverless-Vehicle Litigation.—Operating mostly within the basic framework of rules produced by initial litigation, the types of civil liability claims associated with

³²⁴ Compare FED. R. EVID. 407 (barring the introduction of evidence regarding a subsequent remedial measure to prove the existence of product defect) with *Ault v. Int’l Harvester Co.*, 13 Cal. 3d 113, 120, 528 P. 2d 1148, 1152, 117 Cal. Rptr. 812, 816 (1974) (permitting the introduction of this evidence).

driverless vehicles likely will evolve and mature during a second phase of litigation, in sync with the increasing capabilities and prevalence of these devices. Some of the tort claims brought within this second stage of litigation will resemble those pursued in earlier cases. Operators of driverless vehicles likely will continue to face claims that they improperly engaged or utilized a vehicle's driverless functions, and manufacturers will have to respond to charges that their products' warnings or designs facilitated these errors. This period also may witness the emergence of more sophisticated claims against users, such as allegations that users overrode safety directions programmed within the vehicle or selected an unreasonably aggressive driving mode.

Meanwhile, as driverless vehicles grow increasingly sophisticated and take over ever more responsibility relative to their human occupants, the principal locus of liability for accidents is expected to transition away from people using these vehicles for transportation and toward the manufacturers of these devices and the software used in them. As this shift occurs, products liability cases will appear that spot and attack increasingly subtle defects in the software and hardware that direct a vehicle's movements and actions. The evolution of software, the development of expectations regarding how it should perform, and the (possible) availability of data that allows for comparison across software platforms will enhance the ability of plaintiffs to pursue design-defect claims in which a particular programming choice associated with an accident is attacked as defective.³²⁵ Especially during the early portion of this phase, some of these claims may concern the combined operation of sensors (what the vehicles should have observed) and software (how the vehicle should have responded to the data it received). As time passes, the emphasis placed upon the latter portion of this equation likely will increase, as plaintiffs and their counsel grow more comfortable in challenging software design decisions.

Once it reaches a sufficient stage of sophistication, litigation over the defectiveness of vehicle software may present difficult technical and moral issues to judges and juries. Programmers of driverless vehicles will have to decide in advance how the vehicle will respond to certain situations in which some sort of accident is unavoidable. In these scenarios, a particular coding decision may reduce the risk of harm to the driver, but impose greater risk upon a passenger or third parties, such as pedestrians (or vice versa). Human drivers already make

these sorts of decisions, and have their conduct reviewed after the fact for reasonableness by judges and juries. Yet the need to have these matters resolved in advance within a vehicle's software code may provide a basis for manufacturers or software suppliers to push for the promulgation of liability-limiting standards for the algorithms used in these contexts. If adopted, these rules may lead to additional safety standards involving other coding matters. Alternatively or in addition, judges may have substantial gatekeeping roles assigned to them in determining whether alternative programming decisions that would address these scenarios represent "reasonable" alternative designs, as many jurisdictions require for presentation of a design-defect claim to a jury.³²⁶

Other claims that may appear within this second phase will be even more novel, and are therefore more difficult to anticipate. Some of these claims may involve intangible harms. The prodigious amount of data generated by driverless vehicles, together with the connected attributes of these devices, will create incentives and opportunities for businesses and individuals to collect and use this information for profit, or for other purposes. Consumers or other affected persons may regard this exploitation of "their" data as injurious. Although most of the resulting cases will be resolved by reference to evolving consumer protection and privacy statutes, the common law of torts, and specifically the privacy torts,³²⁷ may be invoked as a means of deciding who can properly control this information. Some of these disputes may challenge the collection or dissemination of information by vehicle manufacturers or software providers. Other claims may involve "hacking" by hostile third parties.³²⁸ And still other potentially tortious fact patterns, yet unknown, may arise.

Litigation during this period also may challenge distinctions that historically have appeared within products liability law. For example, while products are subject to strict products liability,

³²⁶ RESTATEMENT (THIRD) OF TORTS: PRODUCTS LIABILITY, *supra* note 269, at § 2 cmt. d.

³²⁷ See William L. Prosser, *Privacy*, 48 CAL. L. REV. 383 (1960) (recognizing four distinct common-law privacy torts: intrusion, public disclosure of private facts, false light in the public eye, and (mis)appropriation of one's likeness).

³²⁸ See Brian Leon, *Students from China's Zhejiang University Successfully Hack a Tesla Model S to Win \$10,000*, N.Y. DAILY NEWS (Aug. 8, 2014), <http://www.nydailynews.com/autos/chinese-university-students-successfully-hack-tesla-model-s-article-1.1896540> (discussing how, in response to a challenge and prize offer, within hours a team of university students used a computer to "control[] the [Tesla's] lights, horn, sunroof, and door locks remotely all while the car was in motion").

³²⁵ David C. Vladeck, *Machines Without Principals: Liability Rules and Artificial Intelligence*, 89 WASH. L. REV. 117, 132 (2014).

services are not.³²⁹ Under prevailing case law, aeronautical charts represent a product,³³⁰ while chauffeurs are regarded as providing a service. Given this divide, it is unclear whether and when the software incorporated within driverless vehicles will be regarded as a product or as a service.³³¹ Also, the post-sale responsibilities of product manufacturers are governed mostly by the law of negligence. In applying this standard, courts have not imposed significant responsibilities upon manufacturers to update products that were not defective at the time they were sold. This too may change, since yesterday's programming decisions for driverless vehicles may produce unreasonable dangers within a very short period of time, and it is expected that software updates for these vehicles will be capable of delivery almost instantaneously and at low cost.³³²

Finally, depending on the path that driverless vehicle technologies follow, during this time new claims may emerge against third parties who neither use nor manufacture driverless vehicles, but are in other ways responsible for their operation on the highways. If a V2I connected vehicle infrastructure becomes prevalent, local governments may face defective programming claims. Likewise, there may appear new business niches associated with the operation of driverless vehicles, such as counterparts to present-day navigation "apps," that promise to enhance the efficiency or otherwise direct the performance of driverless vehicles manufactured by a different company. Original manufacturers may argue that use of these "apps" amounts to the misuse or alteration of a product, which may provide them with a defense to a tort action. The makers and retailers of these operation enhancers, meanwhile, may become the subjects of litigation and regulation.

c. Stage Three: A Mature Claiming Environment.—At some point, personal injury litigation associated with driverless vehicles likely will reach a mature state. Novel issues still may appear, but not as often, and most tort claims involving driverless vehicles will become routinized, as occurred between the 1920s and the 1960s with claims involving conventional automobiles.³³³ This routinization will affect a diminished and ever-shrinking pool of

³²⁹ RESTatement (THIRD) OF TORTS: PRODUCTS LIABILITY, *supra* note 269, § 19.

³³⁰ See Abney, *supra* note 286.

³³¹ See Smith, *supra* note 319, at 1817–19.

³³² See *id.* at 1803–08.

³³³ Samuel Issacharoff & John Fabian Witt, *The Inevitability of Aggregate Settlement: An Institutional Account of American Tort Law*, 57 VAND. L. REV. 1571, 1618 (2004).

personal injury claims involving vehicles, owing to the safety benefits of driverless vehicles relative to conventional vehicles and the former's replacement of the latter on the nation's highways.

It is unclear whether persons who suffer injuries associated with driverless vehicles during this mature stage will seek relief primarily through the courts, or through other avenues. As just noted, the anticipated decline in the frequency and severity of vehicle accidents will be accompanied by a proliferation of parties or entities potentially contributing to the remaining accidents (OEMs, programmers, hardware suppliers, state and federal municipalities, and providers of apps and V2V and V2I communications). If these groups are routinely added to the litigation mix and thereby complicate the liability equation, a different compensation system may well recommend itself. Although no-fault insurance has presented its own set of problems, a form of no-fault insurance may better fit an age of driverless vehicles than it does the present fault- and defect-based legal regime. The National Childhood Vaccine Injury Act of 1986 offers yet another model for an alternative compensation system that may emerge.

3. Conclusions

The common grounds for civil liability for personal injuries associated with the manufacture, use, and operation of driverless vehicles likely will evolve over time. Early lawsuits will draw heavily from existing law that relates the rights and responsibilities of the makers and users of conventional vehicles. Claims gradually will grow more sophisticated and begin to critically evaluate the capabilities of driverless vehicles as a distinct technology.

As other commentators have noted, as primary responsibility for decision making while driving shifts from human drivers to driverless vehicles, the principal repository of liability for everyday traffic accidents correspondingly will drift away from individual vehicle operators and toward product manufacturers. Automobile-accident plaintiffs in the future presumably will rely increasingly on the strict-liability theories of recovery that are available against defendants involved in the supply chain for products, instead of the negligence principles that apply to human drivers. Over time, driverless vehicles may lead to changes in generic products liability doctrine, although the precise direction of these adjustments is difficult to anticipate.

Eventually, driverless vehicles likely will result in a significant reduction in the total number of lawsuits involving the operation of motor vehicles. Negligence claims against users may remain somewhat more prevalent and persistent than what

some observers presently predict,³³⁴ and unless a transformative change in law occurs, at least some lawsuits against manufacturers will persist. Yet the anticipated overall decline in personal injury litigation associated with automobiles may have important consequences for a substantial segment of the bar for whom these matters represent a significant share of their case portfolios.³³⁵

These prospects all lie far in the future. Presently, the main issue before policymakers concerns whether to avoid this anticipated gradual change through the near-term enactment of statutes or promulgation of regulations that preempt or otherwise limit tort lawsuits associated with driverless vehicles. If conventional vehicles provide any guide, some preemption of tort liability vis-à-vis basic safety features and certain programming choices is probably inevitable in the long run. But the information required for the adoption of sound, long-term regulatory standards has not yet been generated, and broad preemption has not yet been necessary for innovation to occur in this field. Furthermore, the incremental and ongoing development of automated and driverless vehicle technologies militates against premature regulatory strategies—of any stripe—that may be overbroad or off the mark, and prove difficult to amend at a later date.

Finally, policymakers should appreciate that the civil liability law that comes to surround driverless vehicles will itself serve as a foundation for principles later extended to other applications of artificial intelligence, if and when these technologies begin to cause harm. To date, software has not left a particularly large footprint on tort law, primarily because software programming decisions rarely have led to personal injuries. That will change once driverless vehicles become common. It will change even more if and when robots and other products involving sophisticated artificial intelligence become more prevalent and useful. The tort law that coalesces around driverless vehicles will represent the opening chapter of a longer narrative in which our society decides where and how to address and account for risks associated with these devices.

³³⁴ *But cf.* RAND REPORT, *supra* note 181, at 118 (“Overall, we do not anticipate that liability for individual drivers will be a problematic obstacle or deterrent to the use of AV technologies.”); *id.* at 132 (“The existing liability regime does not seem to present unusual liability concerns for owners or drivers of vehicles equipped with AV technologies.”).

³³⁵ See Erik Turkewitz, *Will Google Cars Eviscerate the Personal Injury Bar?*, N.Y. PERSONAL INJURY LAW BLOG (Dec. 22, 2014), <http://www.newyorkpersonalinjuryattorneyblog.com/2014/12/will-google-cars-eviscerate-the-personal-injury-bar.html>.

V. CRIMINAL LAW AND PROCEDURE

Driverless vehicles will develop a complicated, multifaceted relationship with federal and state criminal law and procedure.³³⁶ These devices may lead to the recognition of new crimes, even as they reduce the overall number of traffic infractions and other crimes committed with automobiles. They also may enhance the surveillance capabilities of the government, even as they diminish the number of traffic stops that, today, represent the most common form of interaction between police officers and the general public.³³⁷

These developments will take time to unfold. More immediately, driverless vehicles will inherit a large body of existing laws that address the proper operation of motor vehicles, their required equipment, and the misuse or exploitation of these devices. Many of these laws attach criminal penalties to violations of their provisions.

Some of these existing statutes admit to ready application to driverless vehicles. Other laws may require revisions to clarify how they will apply, if at all, to this new form of transportation. And still other laws, presently not in existence, may impose new criminal prohibitions that specifically address novel antisocial behaviors associated with driverless vehicles.

The future also may see a reevaluation of who, or what, should be held criminally liable for crimes involving driverless vehicles. As discussed in connection with this report’s discussion of civil liability, the automation of functions associated with the operation of driverless vehicles will entail a shift in responsibility from human drivers to the automobiles themselves and the systems they rely upon. Just as this shift may lead to the reconsideration of who may be held liable in a civil action for damages after an accident involving a driverless vehicle, it also may call into question existing assignments of criminal responsibility.

A. Criminal Laws

Federal and state laws relate hundreds of crimes pertinent to motor vehicles. A basic taxonomy would

³³⁶ Other authors also have considered the topic addressed in this section. *E.g.*, Frank Douma & Sarah Aue Palodichuk, “*But Officer, it Wasn’t My Fault...the car did it,*” *Criminal Liability Issues Created by Autonomous Vehicles*, 52 SANTA CLARA L. REV. 1157 (2012); Jeffrey K. Gurney, *Driving into the Unknown: Examining the Crossroads of Criminal Law and Autonomous Vehicles*, 5 WAKE FOREST J. LAW & POL’Y 393 (2015).

³³⁷ CHRISTINE EITH & MATTHEW DUROSE, *CONTACTS BETWEEN POLICE AND THE PUBLIC*, 2008, U.S. Department of Justice, Office of Justice Programs, Special Report NCJ234599, 1 (Oct. 2011).

distinguish among basic regulatory offenses (e.g., equipment violations and simple deviations from rules of the road); crimes that address aggravated forms of user misconduct (e.g., driving under the influence of alcohol, hit-and-run); specific forms of more general crimes (e.g., automobile theft, carjacking); and criminal conduct that are facilitated by or otherwise connected to motor vehicles, but as to which the pertinent criminal prohibition does not specifically reference or require these devices (e.g., transportation of narcotics for purposes of sale). Crimes within the first of these categories tend to carry modest penalties and minimal mens rea (intent) requirements. The other types of crimes run the gamut from infractions punishable by only a fine to serious felonies that can carry long prison terms.

Some, though not necessarily all, of these offenses will apply to driverless vehicles, with little need for translation or modification. For example, many of the basic equipment requirements found within state vehicle codes, such as the common requirement that a vehicle have operating headlamps, presumably will apply both to driverless vehicles and to vehicles with active human drivers. There may come a time when the driverless vehicles are so predominant on the roads and their sensory capabilities so robust that a subset of these safety laws may become obsolete. But until then, it is expected that these rules will continue in force, and will be of general application.

Other provisions of state vehicle codes may require some modifications to account for the distinct characteristics of driverless vehicles, as related below.³³⁸

³³⁸ As a threshold matter, state vehicle codes tend to presume that vehicles have a “driver.” To this point, the existence and nature of a “driver” both have been sufficiently obvious that states have not provided a robust definition of this term. With driverless vehicles, this will change. One leading commentator has observed that at present, the ambiguity inherent in the word “driver,” as that term is used in various contexts, means that driverless vehicles are “probably” legal in the United States, but under present law “there is likely to be some person connected to the vehicle who must be licensed, who may need to be physically present, and who must act prudently.” Smith, *Automated Vehicles Are Probably Legal in the United States*, *supra* note 180, at 480 (footnotes omitted). While some individuals and entities may be comfortable with these ambiguities, others may not be, and will continue to press for laws that clarify how a driverless vehicle may be utilized without fear of criminal sanctions.

In this vein, some states already have enacted laws that permit road testing of autonomous vehicles, under certain conditions. On the issue of compliance with traffic laws, regulations promulgated in Nevada prescribe that “a person shall be deemed the operator of an autonomous vehicle which is operated in autonomous mode when the person causes the autonomous vehicle to engage, regardless of whether the person is physically present in the vehicle while it is engaged,” Nev. ADMIN. CODE § 482A-020(2) (2014), and “For the purpose of enforcing the traffic laws and other laws applicable to

1. Reassignment and Recasting of Criminal Liability

In some contexts, driverless vehicles eventually may lead to the reassignment of criminal liability from its current bearer to someone (or something) else, or to the replacement of low-level sanctions with other methods of deterrence and punishment. For example, current state laws typically make the “driver” or “operator” of a vehicle liable for failing to stop at a stop sign.³³⁹ If a driverless vehicle fails to obey such a sign, conceivably the human user of the vehicle could continue to be held liable. To reach this result, however, the user either would have to be considered the “driver” or “operator” of the vehicle, or the pertinent statute would have to be amended to make mere users responsible for their actions.

Continued assignment of liability to users seems likely insofar as Level 3 vehicles are involved.³⁴⁰ That said, the prospect of criminal liability may undermine key benefits associated with driverless vehicles, especially as these devices grow safer and the need for human oversight diminishes. As time passes and the public grows more comfortable with driverless vehicles, governments may find it appropriate to revisit the imposition of criminal liability on passive users of advanced driverless vehicles.³⁴¹ In its place, governments could fine or impose other penalties upon the manufacturers of vehicles that commit traffic violations, or upon the makers of software or other components that direct these devices; they could simply remove these vehicles from operation; or they could adopt some other response.

Debates over whether to shift responsibility for traffic infractions from users to third parties may be contentious, however. Prevailing notions regarding the responsibility of drivers and users for their automobiles may prove difficult to dislodge. It also may be unclear for some time who, as among users and various product manufacturers, bears responsibility for various aspects of a vehicle’s performance. This confusion may counsel against the reassignment of liability, at least for some time. It is possible that an interregnum period will appear in which drivers will be permitted to claim a defense by ascribing an improper traffic maneuver to a self-driving function, but no direct liability will attach to the manufacturer or anyone else for this error.

drivers and motor vehicles operated in this State, the operator of an autonomous vehicle that is operated in autonomous mode shall be deemed the driver of the autonomous vehicle regardless of whether the person is physically present in the autonomous vehicle while it is engaged.” *Id.*, § 482A-030(2).

³³⁹ E.g., CAL. VEH. CODE § 22450 (West 2000).

³⁴⁰ See Gurney, *supra* note 336, at 415–16.

³⁴¹ *Id.*

2. Rules of the Road

As the stop sign example above indicates, although driverless vehicles will be subject to most or all of the prevailing “rules of the road,” they also may occasion changes or additions to existing directives. Some of these shifts likely will precede the broad diffusion of driverless vehicles, while others will evolve gradually, over the course of many years. As previously discussed, with automobiles the first rules of the road and equipment requirements related to registration and licensing, permissible spheres of usage, etiquette when interacting with other forms of transportation, the necessary (basic) safety equipment, and speed limits. Other, more nuanced rules took longer to appear. A similar response to driverless vehicles (already incipient in those states that have permitted the limited road testing of these devices) would include, early on, such basic matters as vehicle registration, licensing (including driver qualifications), areas in which driverless vehicles may be used, necessary conduct when interacting with conventional vehicles, insurance requirements, and a clarification of who serves as a “driver,” “operator,” or controller of these devices. Other rules would appear later, when proper policy would hinge on the particular path that this technology has taken in its development and adoption.

3. Other Driving Offenses

Other existing crimes likewise may require modifications to account for how driverless vehicles are used. Hit-and-run statutes, for instance, commonly require the “driver” of a vehicle to stop and give both information and assistance at the site of an accident.³⁴² A driverless vehicle may be fully capable of transmitting the information required by these laws. But direct human engagement may be required for the provision of medical assistance. These statutes therefore may have to be rewritten or supplemented to assign greater responsibilities to “users” or “occupants” of driverless vehicles in the event of an accident. Other traffic laws that impose similar duties on drivers or operators may require comparable adjustments.

These changes may occur along different timetables across the states. With the crime of driving under the influence of alcohol, for example, the appearance of driverless vehicles may lead some states to amend their DUI laws (which commonly prohibit “driving” or “operating” a motor vehicle while in a prohibited state or degree of intoxication) to encourage potentially inebriated drivers to avail themselves of a driverless option, such as a for-hire driverless taxi.³⁴³ A

³⁴² CAL. VEH. CODE §§ 20001, 20003(a) (West 2000 & Supp. 2015).

³⁴³ See Gurney, *supra* note 336, at 421–23 (discussing this possibility).

state might work toward this goal by permitting the use of a Level 3 vehicle in situations where it would be impermissible to drive or operate a vehicle that requires more human engagement. But other states may regard the ability of human user to reassert control over even a Level 3 vehicle as a sufficient basis for a DUI offense. If states vary in their responses, experiences under different regimes likely will inform the approaches taken to this issue when more advanced, Level 4 vehicles appear.

4. Generic Crimes

Driverless vehicles also may make it easier to commit other crimes not inherently connected to automobiles.³⁴⁴ Their potential for use as unmanned “drones” suggests that they could be deployed for terrorist purposes. Terrorists or other third parties also may try to “hack” individual vehicles or the system in which these devices operate—either to trigger collisions or simple confusion, or to gain access to data compiled by driverless cars for purposes of surveillance or profit.

It is unclear whether new criminal laws will be necessary to address these hypothetical scenarios. Most third-party criminal behavior involving driverless cars already is captured by existing crimes, such as laws that prohibit computer “hacking”³⁴⁵ or the unauthorized transportation of explosive devices.³⁴⁶ Nevertheless, the existence of generic crimes will not necessarily sate public demand for an additional criminal prohibition to serve as a direct, firm response to a novel threat. The relatively recent adoption of “carjacking” laws offers a case in point. Although the conduct associated with carjacking amounts to robbery, a crime of ancient vintage, in the early 1990s several states and the federal government responded to amplified fears about this sort of offense by enacting special carjacking statutes that attached heightened penalties to the use of force to commandeer an automobile.³⁴⁷ Alternatively, use of driverless vehicles in the commission of a crime may be made the subject of a criminal “enhancement,” parasitic to an existing offense, whereby a stiffened penalty may be imposed when a crime is committed using a driverless vehicle.

³⁴⁴ Douma & Palodichuk, *supra* note 336, at 1159.

³⁴⁵ Every state has some form of computer-crime law on the books. Jordan M. Blanke, *Criminal Invasion of Privacy: A Survey of Computer Crimes*, 41 JURIMETRICS 443, 449 (2001).

³⁴⁶ E.g., 18 U.S.C. § 842 (2012).

³⁴⁷ E.g., Anti Car Theft Act of 1992, Pub. L. No. 102-519, 106 Stat. 3384; Act of Sept. 30, 1993, ch. 611, 1993 Cal. Stat. 3456.

5. New Crimes

In addition to enhancing existing criminal capabilities, driverless vehicles also may inspire relatively unprecedented forms of misconduct, unique to the technology, that in turn generate new criminal laws. The recent spate of state laws that criminalize “sexting” and “revenge pornography” illustrate that although some time may pass before it becomes apparent that a new technology is being utilized in a manner that compels the creation of a new crime,³⁴⁸ legislatures can respond quickly to such concerns once they arise.³⁴⁹ One type of new crime that may become associated with driverless vehicles would involve user modification of the software installed in these devices. It has been observed that just as the users of cellular phones may “hack” their devices to enhance their capabilities, users of driverless vehicles likewise may try to override functions within their vehicles that limit the speeds at which they operate, or control other aspects of their performance.³⁵⁰ This sort of owner modification of driverless vehicles may become the subject of criminal liability, as hacking by a third party (or odometer tampering by a vehicle seller) already are.

Yet these concerns about new criminal capabilities remain speculative at this point. One lesson that emerges from innovations of the past is that criminal laws enacted at an early phase of a technology’s development often prove stubbornly resistant to change, even as the technology grows more sophisticated, patterns of use and misuse shift, vocabularies surrounding the technology change, and a different policy response becomes increasingly desirable. This intransigence can be particularly acute when crimes have been enacted and any modification would reduce the scope of an offense or lessen the attached punishment. The “stickiness” of early adopted policies tends to counsel in favor of significant deliberation prior to the recognition of any stringent and severe new criminal laws concerning a new technology.

³⁴⁸ The first law specifically prohibiting “obscene phone calls,” for example, appears to have been enacted in 1907, decades after telephones first appeared. An Act Prohibiting the Uttering of Lascivious or Obscene Language over Telephones in this State, ch. 249, 1907 N.D. Laws 387.

³⁴⁹ See Sameer Hinduja & Justin W. Patchin, *State Sexting Laws*, CYBERBULLYING RES. CTR. (2015), <http://cyberbullying.us/state-sexting-laws.pdf> (indicating that as of January 2015, 20 states had enacted laws that prohibit “sexting”). As of April 2015, 18 states have enacted “revenge porn” laws that criminalize the nonconsensual online posting of sexually explicit images. Alex Ronan, *Could All of These New Revenge-Porn Laws Actually Be a Bad Thing?*, N.Y. MAG. (April 16, 2015), <http://nymag.com/thecut/2015/04/why-regulating-revenge-porn-is-so-tricky.html>.

³⁵⁰ RAND REPORT, *supra* note 181, at 70–71.

6. Federal Crimes

The discussion above presumes that states will continue to occupy the lead role in crafting and enforcing criminal laws applicable to motor vehicles operated on the highways. That said, the federal government also has played a role in the creation and enforcement of crimes involving motor vehicles. Back in 1919, Congress passed the Dyer Act, also known as the National Motor Vehicle Theft Act, which made interstate motor vehicle theft a federal crime.³⁵¹ This law provided federal prosecutors with a steady stream of cases for several decades. More recently enacted federal crimes applicable to automobiles, such as the odometer fraud provisions of the Motor Vehicle Information and Cost Savings Act of 1972³⁵² and the carjacking crime within the Federal Anti Car Theft Act of 1992,³⁵³ today also produce a small number of federal prosecutions. More commonly, federal prosecutors pursue generic crimes that can be facilitated by automobiles, such as the interstate transportation of narcotics.

Driverless vehicles may lead to new federal crimes. The Commerce Clause of the United States Constitution confers upon Congress the power to regulate interstate commerce. Courts have held that the federal carjacking statute represents a valid exercise of this authority,³⁵⁴ paving the way for federal crimes that would address interference with an increasingly networked highway system. Yet when and how the federal government will exercise this authority is at this point unclear. In this legal context, as in other spheres, the circumstances surrounding the development and spread of driverless vehicles likely will influence the timing and nature of federal engagement with these devices.

B. Criminal Investigations

If they become common, driverless vehicles also will have an important effect on police investigations. These devices will alter the existing “equilibrium” between privacy and security by enabling both new crimes and new methods of surveillance.³⁵⁵ Among

³⁵¹ National Motor Vehicle Theft Act, Pub. L. No. 66-70, 41 Stat. 324 (1919).

³⁵² Motor Vehicle Information and Cost Savings Act, Pub. L. No. 92-513, §§ 403–06, 86 Stat. 947, 961 (1972).

³⁵³ Anti Car Theft Act of 1992, Pub. L. No. 102-519, 106 Stat. 3384. See also F. Georgann Wing, *Putting the Brakes on Carjacking or Accelerating It – The Anti-Carjacking Act of 1992*, 28 U. RICH. L. REV. 385, 410–22 (1994) (discussing the legislative history of this law).

³⁵⁴ E.g., *United States v. Runyon*, 707 F.3d 475, 489-90 (4th Cir. 2013).

³⁵⁵ See Orin S. Kerr, *An Equilibrium-Adjustment Theory of the Fourth Amendment*, 125 HARV. L. REV. 478 (2011) (describing how new technologies may disrupt this equilibrium).

their privacy consequences, driverless vehicles will collect a tremendous amount of information regarding their users' movements, information that law enforcement may want to obtain without a search warrant. It is anticipated that these efforts will be challenged by defendants and others who regard such efforts as impermissible under the Fourth Amendment to the United States Constitution.³⁵⁶

These arguments will implicate what is presently a hotly contested area of law. Under the Fourth Amendment, the government engages in a "search" either when it intrudes upon an individual's subjective expectation of privacy, to the extent that society is prepared to regard such an expectation as reasonable,³⁵⁷ or when it commits an information-gathering "trespass" upon a person or their papers, houses, or effects.³⁵⁸ For a "search" to be lawful, the government first must have obtained a search warrant that authorizes the search, or a recognized exception to the warrant requirement must apply. A search warrant can be obtained only on a showing of probable cause, a standard equated with a "fair probability" that the search will yield evidence of a crime.³⁵⁹

A recent decision by the United States Supreme Court regarding prolonged government surveillance of vehicle movements yielded a consensus that GPS surveillance (at least on the facts presented) amounts to a "search" that triggers Fourth Amendment protections, but a split over the analytical approach that compels that conclusion. In 2012, the Court held, unanimously, in *United States v. Jones* that a "search" occurred when government agents placed a GPS device on a suspect's automobile and then used that device to track the suspect's movements for 28 days.³⁶⁰ Significantly, however, the justices did not agree on a single rationale for this holding. Five justices relied upon the "trespass" theory,³⁶¹

³⁵⁶ The Fourth Amendment provides:

The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no warrants shall issue, but upon probable cause, supported by oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.

U.S. CONST. amend. IV.

³⁵⁷ *Katz v. United States*, 389 U.S. 347, 361, 88 S. Ct. 507, 19 L. Ed. 2d 576, 587 (1967) (Harlan, J. concurring).

³⁵⁸ See, e.g., *United States v. Jones*, ___ U.S. ___, 132 S. Ct. 945, 949, 181 L. Ed. 2d 911 (2012) (holding that the government engages in a "search" when it physically occupies a person's vehicle for the purpose of obtaining information).

³⁵⁹ *Illinois v. Gates*, 462 U.S. 213, 238, 103 S. Ct. 2317, 2332, 76 L. Ed. 2d 527, 548 (1983).

³⁶⁰ *Jones*, 132 S. Ct. at 949.

³⁶¹ *Id.*

while another five (one justice joining both camps) would have held that the prolonged use of the GPS device under the specific circumstances presented (involving an investigation of suspected narcotics trafficking) violated the defendant's reasonable privacy expectations.³⁶²

Although *Jones* signifies that a majority of the present Court apparently regards trespassory and some non-trespassory surveillance of vehicle movements as implicating the Fourth Amendment, it remains unclear precisely when the government's non-trespassory acquisition of information regarding a driverless vehicle's whereabouts will be treated as a "search." With driverless vehicles, this collection could occur along different avenues. The government may try to obtain this information through infrastructure built for connected-vehicle, including V2I, purposes, or through a more basic repurposing of existing surveillance tools such as cameras and license plate readers positioned on and about the highways.³⁶³ Law enforcement also may invoke the "third-party doctrine," under which an individual lacks a reasonable expectation of privacy in information that he or she voluntarily communicates to a third party,³⁶⁴ to justify the warrantless acquisition of information regarding driverless-vehicle use from communications providers or from companies that manufacture or maintain driverless vehicles.

Presently, one cannot predict with certainty how these warrantless-surveillance scenarios will be resolved. At least one member of the U.S. Supreme Court has expressed reservations about the continued application of the third-party doctrine,³⁶⁵ and it is possible that this rule and related Fourth Amendment doctrine will change before driverless vehicles become common.

Searches of driverless vehicles themselves, as opposed to mere surveillance of their movements, also may raise interesting legal issues. Automobiles represent "effects" under the Fourth Amendment to the United States Constitution, and their owners and possessors generally can claim a reasonable expectation of privacy as against physical intrusions

³⁶² *Id.* at 957–64 (Alito, J., concurring).

³⁶³ Devlin Barrett, *U.S. Spies on Millions of Drivers*, THE WALL STREET JOURNAL, Jan. 26, 2015, at A1.

³⁶⁴ See *Smith v. Maryland*, 442 U.S. 735, 743–44, 99 S. Ct. 2577, 2581–2584 (1979); *United States v. Miller*, 425 U.S. 435, 443, 96 S. Ct. 1619, 1624, 48 L. Ed. 2d 71, 79 (1976). See also Orin S. Kerr, *In Defense of the Third-Party Doctrine*, 107 MICH. L. REV. 561, 563 (2009) (discussing this doctrine and critiques thereof).

³⁶⁵ See *Jones*, 132 S. Ct. at 957 (Sotomayor, J., concurring).

by the government.³⁶⁶ Therefore, a police officer's entrance into and search of a vehicle amounts to a "search" that requires a warrant or warrant exception.

Several such exceptions apply to automobiles. These exceptions are premised on rationales including the pervasive regulation of these devices, their susceptibility to movement, and the fact that they tend to be operated in public places.³⁶⁷ With regard to automobiles, the most commonly invoked warrant exceptions consist of:

- *Consent*: Police may search a vehicle if they receive voluntary consent to search from someone with actual or "apparent" authority.³⁶⁸

- *The "automobile exception"*: Police also may search a vehicle, as thoroughly as they could if they had a search warrant, if there is probable cause that the vehicle contains contraband or evidence of a crime.³⁶⁹

- *Searches incident to arrest*: Police may search the area of a vehicle within grabbing distance of a lawfully arrested recent occupant, and may search the interior of a vehicle's passenger compartment if it is reasonable to believe that the vehicle contains evidence of the offense of arrest.³⁷⁰

- *Vehicle frisks*: Police may search the passenger compartment of a vehicle for a weapon if the officer has reasonable suspicion that the vehicle contains a weapon, and that an occupant of the vehicle may become armed and dangerous if allowed access to the weapon.³⁷¹

- *Inventory searches*: A lawfully impounded vehicle may be physically searched by law enforcement pursuant to preexisting inventory policies;³⁷² and

- *Regulatory searches*: Under limited circumstances, police may search a vehicle to ensure compliance with basic registration and regulatory requirements.³⁷³

³⁶⁶ See *California v. Carney*, 471 U.S. 386, 391–92, 105 S. Ct. 2066, 2069–2070 (1985) (discussing the premises behind the "automobile exception" to the warrant requirement); *Cardwell v. Lewis*, 417 U.S. 583, 590, 94 S. Ct. 2464, 2469, 41 L. Ed. 2d 334 (1974) (same).

³⁶⁷ *Id.*

³⁶⁸ *Florida v. Jimeno*, 500 U.S. 248, 251, 111 S. Ct. 1801, 1803 (1991); *Illinois v. Rodriguez*, 497 U.S. 177, 188, 110 S. Ct. 2793, 2801 (1990).

³⁶⁹ *California v. Acevedo*, 500 U.S. 565, 580, 111 S. Ct. 1982, 114 L. Ed. 2d 619, 634 (1991).

³⁷⁰ *Arizona v. Gant*, 556 U.S. 332, 351, 129 S. Ct. 1710, 1723–1724, 173 L. Ed. 2d 485, 501 (2009).

³⁷¹ *Michigan v. Long*, 463 U.S. 1032, 1049, 103 S. Ct. 3469, 3480–3481, 77 L. Ed. 2d 1201, 1219–1220 (1983).

³⁷² *South Dakota v. Opperman*, 428 U.S. 364, 372, 96 S. Ct. 3092, 3098–3099, 49 L. Ed. 2d 1000, 1007 (1976).

³⁷³ *New York v. Class*, 475 U.S. 106, 118, 106 S. Ct. 960, 968, 89 L. Ed. 2d 81, 93 (1986).

There also exist other discrete circumstances in which vehicles may become subject to government inspection without a search warrant, such as when a vehicle enters the country through an international border.³⁷⁴

In many circumstances, these warrant exceptions will apply to driverless vehicles just as they do to conventional automobiles. In other cases, however, the nature of the evidence that law enforcement officers may seek to obtain from driverless vehicles may complicate the necessary Fourth Amendment analysis. In this respect, the culling of digital evidence from driverless vehicles by police may prove particularly sensitive. Recently, in *Riley v. California*,³⁷⁵ the U.S. Supreme Court barred the warrantless search of cellular telephones incident to the arrests of their possessors.³⁷⁶ In reaching this result, the Court emphasized the quantity and potentially sensitive nature of the digital information in these devices.³⁷⁷ As applied to driverless vehicles, this ruling will encourage defendants to challenge the government's warrantless acquisition of digital information from their vehicles, even when this action is taken pursuant to a recognized warrant exception. A defendant in such a case could argue with some force that the collection of broad swaths of location data or other information concerning vehicle use pursuant to, for example, the automobile exception is just as unreasonable as the warrantless search of a cell phone incident to arrest was deemed to be in *Riley*.³⁷⁸

Finally, and perhaps most intriguingly, the emergence of driverless vehicles may function to *limit* police interactions with the public. If driverless vehicles lead to fewer traffic violations and impaired driving offenses, there likely will be fewer occasions for police to pull motorists over. This diminution of traffic stops could have profound consequences for police staffing and deployment, and on the use of traffic stops to enforce other substantive criminal prohibitions.

C. Conclusions

The criminal laws that will become attached to driverless vehicles will not be written on a blank slate. These devices will be subject to a large body of existing law applicable to conventional motor vehicles. And between now and when driverless vehicles

³⁷⁴ *United States v. Flores-Montano*, 541 U.S. 149, 155, 124 S. Ct. 1582, 158 L. Ed. 2d 311, 318 (2004).

³⁷⁵ ___ U.S. ___, 134 S. Ct. 2473, 189 L. Ed. 2d 430 (2014).

³⁷⁶ *Id.* at 2485.

³⁷⁷ *Id.* at 2489–91.

³⁷⁸ See Dorothy J. Glancy, *Sharing the Road: Smart Transportation Infrastructure*, 41 FORDHAM URB. L.J. 1617, 1649–51 (2014) (discussing the *Riley* case and its implications for driverless vehicles).

become common, the law likely will evolve to respond to the capabilities of vehicles that incorporate increasingly sophisticated autonomous functionalities.

In the future, as now, most of the crimes pertinent to the operation of driverless vehicles likely will take the form of “rules of the road” and equipment violations. These crimes lie on the border of administrative (civil) and criminal offenses, carry modest penalties, and require limited or no proof of culpable intent. Some of these offenses will be applied to the users of driverless vehicles in much the same way that they presently pertain to users of conventional vehicles. Others will require adjustments in their vocabulary or substantive provisions to make sense as applied to driverless vehicles.

Furthermore, new offenses likely will appear to govern how driverless vehicles should be operated. Nevertheless, while driverless vehicles therefore may occasion an increase in the number of regulatory offenses that are recognized, if they become common, they likely will lead to a reduction in the number of offenses committed.

Other, more serious crimes specific to driverless vehicles probably will take longer to appear. Some of these crimes will evolve gradually while others will fall in place during opportune policy windows. If the history of computer crimes provides any indication, legislators and prosecutors likely will rely on existing offenses to address most misbehavior involving driverless vehicles for a while before sufficient interest develops for the enactment of offenses that explicitly address criminal behavior that involves these devices. Even a single real or hypothetical crime may prove sufficient to spark such a movement, however.

VI. THE EVOLVING INSURANCE MATRIX FOR DRIVERLESS VEHICLES

A. Introduction

Insurance issues arising from the relationship among driverless vehicles, insurers, manufacturers, and policymakers will present a host of interesting challenges. The reduction in injuries and the reduced responsibility and liability on the part of operators will benefit the public and the operators, but it will also present challenges to the business plans of many insurers. Although the cost of injuries will fall, there will be some need to insure the increased legal responsibility on the part of those in the commercial chain. This is a very different model of insurance. As vehicles become more connected, cyber risks will present a new set of insurance challenges. In addition, while the federal government is empowered to regulate insurance under the commerce clause of

the U.S. Constitution, most insurance regulation has been delegated by the federal government to the states. Consequently, state regulation varies and sometimes presents challenges to accommodate a system designed for cars with “drivers” (who are often “at fault”) to the new paradigm.

B. Regulation of Automobile Insurance

The business of insurance moves in interstate commerce.³⁷⁹ Insurance may, therefore, be regulated by the federal government. In 1945, however, Congress ceded the regulation of insurance to the states in the McCarran-Ferguson Act.³⁸⁰ With rare exception, Congress has been content to leave regulation of insurance to state regulators. When uniformity is desirable or state regulated markets do not work well, Congress sometimes exercises its power to intervene. Examples include: the Employee Retirement Income Security Act of 1975 (ERISA),³⁸¹ the National Flood Insurance Program (NFIP),³⁸² the Product Liability Risk Retention Act of 1981³⁸³ and 1986,³⁸⁴ and the Patient Protection and Affordable Care Act (ACA) (although the latter’s mandate was upheld as a “tax”).³⁸⁵

After the recent failure of a number of financial institutions, the federal regulation of insurance was again mooted. For insurers whose size may cause existential threats should they become insolvent, the Dodd-Frank Wall Street Reform and Consumer Protection Act imposed capitalization and regulatory requirements beyond those imposed by state regulators.³⁸⁶ Dodd-Frank also established the Federal Insurance Office (FIO) attached to the Treasury Department. The FIO’s role to date has been largely to monitor insurance issues. Mandatory insurance rates for interstate trucking also fall within the federal purview.

³⁷⁹ United States v. South-Eastern Underwriters Ass’n, 322 U.S. 533, 64 S. Ct. 1162, 88 L. Ed. 1440 (1944) (holding that federal antitrust laws apply to insurance).

³⁸⁰ 15 U.S.C. §§ 1011–1015 (2012) (federal antitrust laws apply to insurance to the extent insurance is not regulated by the states).

³⁸¹ 29 U.S.C. §§ 1001–1461 (2012) (especially with respect to self-funded employer health plans).

³⁸² 42 U.S.C. § 4104c (2012).

³⁸³ 15 U.S.C. §§ 3901 et seq. (2012).

³⁸⁴ 15 U.S.C. §§ 3901–3906 (2012).

³⁸⁵ National Federation of Independent Business v. Sebelius, 567 U.S. ___, 132 S. Ct. 2566, 183 L. Ed. 2d 450 (2012).

³⁸⁶ See Ian Katz, *Republicans Order Records in New Attack on FSOC Transparency*, BLOOMBERG Bus. (May 29, 2015)<http://www.bloomberg.com/news/articles/2015-05-29/republicans-demand-records-in-new-attack-on-fsoc-transparency>. The Financial Stability Oversight Council (FSOC) is the federal entity charged with deciding whether a financial institution is “systemically important.”

The regulation of automobile insurance, therefore, falls within the purview of the individual states. Each state has a commissioner or similar official who oversees insurance regulation. Some are elected (as in California), but most are appointed (as in Nevada).³⁸⁷ These officials belong to the National Association of Insurance Commissioners (NAIC). The NAIC meets regularly to consider issues of broad significance to insurance and to develop and propose model laws and regulations to promote consistency among states. The NAIC, however, does not have the power to impose its model rules on states.

All states endorse the rule that insurance rates may not be excessive, inadequate, or unfairly discriminatory.³⁸⁸ One of the main purposes of insurance regulation is to assure that insurers remain solvent enough to pay claims. This purpose is served by the requirement that rates not be “inadequate.” Regulators regularly review the financial condition of insurers to assure their solvency. In the context of insurance, “unfairly discriminatory” means that, *so far as practical*, rates should reflect risk, expenses, and reasonable profit. “Excessive” means that insureds are being overcharged because the rate exceeds these parameters. In addition, all states have some form of insurance guarantee fund (funded by assessments on insurers) to pay claims should an insurer become insolvent.

In the context of automobile insurance, generally speaking states attempt to achieve these goals using four different models: No-File, File-and-Use, Use-and-File, or Prior-Approval. No-File, File-and-Use, and Use-and-File states rely primarily on competition to set rates. In these states insurers may either file, then use their rates, or use their rates provided they, within a specified amount of time, file them. Prior-Approval states, on the other hand, require that rates be approved before they can be used. California and New York are examples of Prior-Approval states. Even in states other than Prior-Approval states, insurance regulators have the power to disapprove rates under appropriate circumstances.³⁸⁹

In addition to regulating insurance in different ways, states also differ with respect to other details governing automobile insurance. For example, every state except New Hampshire requires some form of

³⁸⁷ A list of states with elected or appointed commissioners is available at *State Commissioners-2014*, NAT'L ASS'N OF INS. COMM'RS, http://www.naic.org/documents/members_state_commissioners_elected_appointed.pdf.

³⁸⁸ See, e.g., CAL. INS. CODE § 1861.05(a) (West 2013) (“No rate shall be approved or remain in effect which is excessive, inadequate, unfairly discriminatory or otherwise in violation of this chapter.”).

³⁸⁹ See generally THE INSTITUTES, INSURANCE REGULATION § 5.4 (Karen Porter, ed. (2010)).

mandatory automobile insurance (usually referred to as Financial Responsibility Laws). These laws are designed to insure that a person injured by an automobile has some recourse against a financially responsible party. The minimum amount of insurance required by states, however, is not consistent. For example, California requires drivers to carry a policy with minimum personal injury limits of \$15,000 per person, \$30,000 per accident, and \$5,000 for property damage (usually referred to as a 15/30/5 policy). This limit has not changed since 1967. Minimum limits in other states vary from 15/30 (AZ, CA, DE, LA, NV) to 50/100 (AK, ME).³⁹⁰ Congress, however, exercised its power under the interstate commerce clause to set a minimum limit of \$750,000 (or more if carrying radioactive or hazardous material) for large trucks through the Federal Motor Carrier Safety Administration (FMCSA).³⁹¹ In May 2015, Nevada became the first state to permit the testing of large (18-wheeler) self-driving trucks on its public highways.³⁹²

C. The Standard Automobile Policy

The standard automobile policy contains a bundle of coverages. While one may think of a “vehicle” as being covered, the insurance actually insures a constellation of people who have some relationship with the vehicle. For example, those covered for liability may include the named insured, any family member residing with the insured, an unemancipated child away at school, and any person driving the car with the permission of an insured. The coverages most pertinent to driverless cars are coverages for liability, physical damage, uninsured/underinsured, collision, and MedPay.³⁹³

D. Automobile Safety

Although automobile insurance is regulated by each state, minimum levels of safety for automobile design are set at the federal level. NHTSA sets standards for the minimum performance of automobiles. NHTSA prescribes standards for,

³⁹⁰ State financial responsibility limits (as of February 2015) are listed at *Compulsory Auto/Uninsured Motorists*, INS. INFO. INST., <http://www.iii.org/issue-update/compulsory-auto-uninsured-motorists>. PIP (no-fault) jurisdictions include AR, DE, DC, FL, HI, KS, KY, MD, MA, MI, MN, NJ, NY, ND, OR, PA, and UT.

³⁹¹ Information on this topic is available at DMV.Org, <http://www.dmv.org/insurance/federal-motor-carrier-insurance.php>.

³⁹² Peter Valdes-Dapena, *Self-driving Semi Hits the Road*, CNN MONEY (May 6, 2015), http://money.cnn.com/2015/05/06/autos/self-driving-truck/index.html?iid=ob_homepage_tech_pool&iid=obnetwork.

³⁹³ See generally *Automobile Insurance—The Personal Auto Policy (PAP)*, THISMATTER.COM, <http://thismatter.com/money/insurance/types/auto-insurance.htm>.

inter alia, windshield wipers, trunk releases, seatbelts, air bags, anti-brake lock (ABS) braking, crashworthiness, electronic stability control (ESC), gasoline mileage, and many other aspects of car construction and design. As with many federal agencies, NHTSA's regulation of automobile design is governed by rigorous cost/benefit analysis.³⁹⁴ NHTSA's requirements preempt any less exacting state standards.³⁹⁵

NHTSA has not adopted any standards for the design or safety of AVs. Indeed, NHTSA has stated that "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."³⁹⁶

In this regulatory vacuum, states are moving forward with their own regulations for testing and driving AVs. Thus far, four states (Nevada, California, Michigan, and Florida) and the District of Columbia have adopted laws or regulations allowing testing of AVs. Virginia has also announced that it will open certain highways for testing. Bills are pending in 11 states, and bills have failed in 7 states.³⁹⁷ It is likely that testing is legal on public highways in the absence

³⁹⁴ See generally Robert W. Hahn and Cass R. Sunstein, *A New Executive Order for Improving Federal Regulation? Deeper and Wider Cost-Benefit Analysis*, 150 U. PA. L. REV. 1489 (2002).

³⁹⁵ 49 U.S.C. § 30103(b)(1) (2012) (state standards valid "only if the standard is identical to the standard prescribed under this chapter").

³⁹⁶ NHTSA PRELIMINARY STATEMENT, *supra* note 184, at 12–13. For a criticism of NHTSA with respect to overseeing safety critical computer programming, see David Benjamin, *Toyota Underestimated “Deadly” Risks, EE Live! keynoter says*, EDN NETWORK (April 02, 2014), <http://www.edn.com/electronics-blogs/now-hear-this/4429744/Toyota-Underestimated—Deadly—Risks--EE-Live—keynoter-says>. The Uniform Law Commission is presently studying the advisability of proposing uniform state laws for driverless vehicles. See *State Regulation of Driverless Cars*, UNIF. L. COMM'N (2015), <http://www.uniformlawcommission.com/Committee.aspx?title=State%20Regulation%20of%20Driverless%20Cars>.

³⁹⁷ The American Association of Motor Vehicle Administrators (AAMVA) maintains a site tracking state legislation, <http://www.aamva.org/WorkArea/linkit.aspx?LinkIdentifier=id&ItemID=5826&libID=5802> (hereinafter "AAMVA Autonomous Vehicle Legislation Chart"). Other related information is collected by the AAMVA at their Autonomous Vehicle Information Library, <http://www.aamva.org/Autonomous-Vehicle-Information-Library/> (last visited Sept. 20, 2015). Meanwhile, legislative developments for automated cars are tracked at Gabriel Weiner & Bryant Walker Smith, *Automated Driving: Legislative and Regulatory Action*, CTR. FOR INTERNET & SOC'Y (Sept. 2, 2015), http://cyberlaw.stanford.edu/wiki/index.php/Automated_Driving:_Legislative_and_Regulatory_Action#State_Bills.

of legislation,³⁹⁸ so the effect of legislation is often to narrow the circumstances under which testing can take place. The Uniform Law Commission is studying whether to adopt a proposed model law for the states, including insurance requirements for drivers.

California Department of Motor Vehicles testing regulations went into effect on September 16, 2014. As mandated by California Vehicle Code Section 38750,³⁹⁹ regulations for the operational stage were due to be completed by January 1, 2015. At the date of this writing, however, the Department has not yet published final, or even proposed, regulations.

E. Insuring Driverless Vehicles

1. How Insurers Create Automobile Insurance Rates

Most insurers create automobile rates in a two-step process. First they create a "rate plan" to calculate a "base rate" (a "base rate" is also called an "indication" in the insurance industry). The insurer looks at its book of the relevant business and asks the question: How much must the insurer collect in premium from each insured to service this book of business over the next rating period, including overhead and profit? For example, if there were 100 insureds all purchasing the same coverage, and it would cost \$100 to service this book of business over the next policy period, then the base rate would be \$1. The insurer must collect, on average, \$1 from each policyholder.⁴⁰⁰

Insurers, however, do not charge all policyholders the same amount. This is because policyholders, even if purchasing the same coverage, do not present the same risk of loss. If the insurer charged the same amount, than those who present lower risk (perhaps \$.80) would pay too much. Not only might this be "unfairly discriminatory," but they would, unless mandated to carry this coverage, likely drop out of the pool because they are not receiving appropriate value for their premium. Even if coverage is mandated, as with automobile insurance, insureds would over time migrate to a different insurer who differentiated rates to more closely approximate the insured's risk. This would leave the insurer with a group of policyholders who present a greater risk than the \$1 base rate. If they paid only \$1 for their policies, but on average cost \$1.20 in losses, the insurer would eventually be out of business. To avoid this outcome (known in the industry as "adverse

³⁹⁸ Smith, *supra* note 180.

³⁹⁹ CAL. VEH. CODE § 38750 (West 2014).

⁴⁰⁰ For a more detailed look at how actuaries actually model automobile insurance rates, see CASUALTY ACTUARIAL SOCIETY, BASIC RATEMAKING (2010), http://www.casact.org/library/studynotes/werner_modlin_ratemaking.pdf.

selection”), the insurer creates a “class plan.”⁴⁰¹ Failure to have a class plan that reasonably discriminates among risks can, then, result in a slow “death spiral” for the insurer.

The class plan applies “rating factors” to adjust the base rate depending on the risk presented by the policyholder. With respect to automobile insurance, many of the rating factors are familiar: age, gender, driving record, miles driven, location, accident history, vehicle class, and credit score (where permitted). California’s regulations, for example, permit the use of 19 rating factors for automobile insurance. Many of these rating factors include a welter of subdivisions.

Applying some rating factors to the above example, A’s rate calculation might look something like this. Ms. A is a female, and females as a group have fewer accidents than males. A neutral rating factor has a relativity of 1, but as a female, she may have a relativity of .90. Thus, her rate would be \$.90. If the average person drives 12,000 miles per year, then 12,000 miles per year would have a relativity of 1. Ms. A, however, drives 20,000 miles per year. This increases the likelihood of an accident and may yield a relativity of 1.10. This would likely offset the benefit Ms. A received because of her gender and move her back to a rate of \$1. Sadly, Ms. A also has a poor driving record, having been convicted of three moving violations in the past 3 years. This driving record may yield a relativity of 1.20. Now Ms. A’s premium would move from \$1 to \$1.20. Ms. A may, however, enjoy some downward adjustments if the automobile is garaged in an area with fewer claims or (if her state permits its use) she has a good credit score. The combination of all of the rating factors and their relativities yields the ultimate rate Ms. A must pay for her policy. The actual process is not as simple as this may appear. It often includes multiplicative algorithms, sequential analysis, and “pumping” and “tempering.”⁴⁰²

Formulating a class plan is largely a zero-sum game. If a relativity lowers a rate for some policyholders, that lower rate must be balanced by a higher rate for some others in the class plan. Thus, a lower rate for a low mileage driver would likely be balanced by higher rates for higher mileage drivers. When done correctly, the net rate over the book of policies will equal the base rate (\$1 in the above example). Politics and social policy play a role in deciding which rate classifications are acceptable. In

⁴⁰¹ See, e.g., CAL. CODE REGS. tit. 10, §§ 2632.7, 2632.8 (2015) (California auto insurers must file a “class plan” with the Department of Insurance).

⁴⁰² See *Spanish Speaking Citizens’ Foundation, Inc. v. Low*, 85 Cal. App. 4th 1179, 1186 (2000); CASUALTY ACTUARIAL SOCIETY, *supra* note 400.

one jurisdiction, territory (where the automobile is garaged), credit score, or gender may be permitted, while not permitted in another.⁴⁰³

Calculating appropriate relativities is a very sophisticated undertaking. It involves analyzing large amounts of data collected by insurers from their own loss experiences and from other sources. This information is then utilized by actuaries to predict the frequency and severity of future losses over the policy period for each of the characteristics evidenced by the insured. This includes predicting future trends in losses. It is possible, for example, that medical or repair costs are predicted to rise over the policy period. It is also possible that gasoline prices may spike or plummet, causing less or more driving and fewer or more accidents over the policy period. Trend is one of the most difficult factors to predict and, where insurance rates are subject to prior approval (as in California), disputes over the future trend for losses occupy much of the regulator’s attention.

2. Emerging Issues for Insuring Driverless Vehicles

“The advent of autonomous cars could revolutionize the world of motor insurance.”⁴⁰⁴

NHTSA estimates that approximately 93 percent of accidents are caused, at least in part, by human error.⁴⁰⁵ NHTSA estimates that the economic cost alone amounts to over \$900 per person per year in the United States. There are approximately \$871 billion in economic and societal losses per year.⁴⁰⁶ The U.S. Centers for Disease Control and Prevention (CDC) reports that in 2012 over 2.5 million Americans were sent to the emergency room because of accidents (approximately 7,000 per day). Nearly 200,000 were hospitalized.⁴⁰⁷ These figures suggest that reducing human error can substantially reduce injuries, deaths, and other costs caused by automobile accidents.

It is likely that self-driving cars will not be totally autonomous for a number of years. They will operate

⁴⁰³ See generally INSURANCE REGULATION, *supra* note 389, § 8.10; Laura Adams, *How Age, Gender and Marital Status Affect Your Auto Insurance* (Mar. 31, 2015), http://www.huffingtonpost.com/laura-adams/how-age-gender-and-marital-status-affect-your-car-insurance_b_6973360.html.

⁴⁰⁴ GILLIAN YEOMANS, AUTONOMOUS VEHICLES: HANDING OVER CONTROL: OPPORTUNITIES AND RISKS FOR INSURANCE 18, LLOYDS, (2014) (hereinafter “LLOYD’S REPORT”).

⁴⁰⁵ NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION, NATIONAL MOTOR VEHICLE CRASH CAUSATION SURVEY, DOT HS 811 059 (July 2008).

⁴⁰⁶ Larry Blincoe, National Highway Traffic Safety Administration, *The Economic and Societal Impact of Motor Vehicle Crashes* DOT HS 812.013, 2 (2015).

⁴⁰⁷ Centers for Disease Control and Prevention, *Motor Crash Injuries*, VITAL SIGNS (Oct. 2014), <http://www.cdc.gov/vitalsigns/crash-injuries/index.html>.

in a shared driving mode (NHTSA Level 3) in which the driver may trust the driving to the car, but must be available on adequate notice to take over the driving. In addition, there will be circumstances, such as the present inability to drive in snow, where the vehicle must be driven by the operator. Thus, there are parts of the country where the benefits of self-driving vehicles will not be as great as in others. It is unlikely, therefore, that the savings from self-driving vehicles will match, or come close to matching, NHTSA's estimates of the current costs of accidents.

For that portion of the shared driving experience in which the operator manually drives the automobile, insurance and the calculation of insurance rates should be fairly straightforward. There will be some adjustments that will account for the fact that the automobile, when in manual mode, will more frequently be driven in more dangerous circumstances. Urban driving, driving in construction zones, or driving in snow or inclement weather are examples. The Casualty Actuarial Society is presently studying how much potential savings may be expected as self-driving cars are introduced.⁴⁰⁸

To the extent that these losses are presently insured (some, such as air pollution, the cost of congestion, and lost productivity, are not), and the cars are moving in self-driving mode, the cars should enjoy lower insurance rates. One study suggested an average saving of \$475/.driver/year.⁴⁰⁹ These savings will either flow to the insurer's bottom line, or, either because of competition or rate regulation, will be savings to the policyholder. One would expect regulators in Prior-Approval states, such as in

⁴⁰⁸ For their first report, see CASUALTY ACTUARIAL SOCIETY AUTOMATED VEHICLES TASK FORCE, RESTATING THE NATIONAL HIGHWAY TRANSPORTATION SAFETY ADMINISTRATION'S NATIONAL MOTOR VEHICLE CRASH CAUSATION SURVEY FOR AUTOMATED VEHICLES (2014), http://www.casact.org/pubs/forum/14fforum/CAS%20AVTF_Restated_NMVCSS.pdf. See also *If Cars Drive Themselves, How Will Actuaries Make Sense of Data to Price the Risks?*, CARRIER MGMT. (May 20, 2014), <http://www.carriermanagement.com/news/2014/05/20/123377.htm>.

⁴⁰⁹ Alain L. Kornhauser, *Smart Driving Cars: History and Evolution of Automated Vehicles* 49 (Sept. 20, 2013), http://orfe.princeton.edu/~alaink/SmartDrivingCars/Presentations/Florida_Seminar_Nov2013_URLsV2.pdf. Other predictions are similar. One recent report advised:

The personal lines sector could fall to 40% of current size. ...The personal lines automobiles sector will likely bear the brunt of the transformation, as it will hold a smaller share of a smaller market. Currently, the personal auto sector accounts for almost \$125 billion in loss costs. By 2040, we believe this sector could cover less than \$50 billion in loss costs.

KPMG, AUTOMOBILE INSURANCE IN THE ERA OF AUTONOMOUS VEHICLES, SURVEY RESULTS 9 (2015), <https://www.kpmg.com/US/en/IssuesAndInsights/Articles/Publications/Documents/automobile-insurance-in-the-era-of-autonomous-vehicles-survey-results-june-2015.pdf>.

California, to make every attempt to pass these savings on to policyholders.

Passing these savings to the policyholder has two principal benefits. It helps consumers with lower rates, and lower rates encourage drivers to purchase these safer vehicles. There are differing estimates as to the cost of equipping an automobile to drive itself. Some are concerned that the higher price will deter many from purchasing the automobile, or the higher price will create a class difference between those who can afford a self-driving vehicle and those who cannot. If, however, insurance savings over the life of the vehicle offset the additional cost of equipping the vehicle, cost should neither deter acceptance nor create two classes of drivers. As with other technology, as driverless cars mature, one would expect dramatic drops in price.

Creating an awareness in consumers of the interplay between the added vehicle cost and the lower insurance costs presents a marketing issue. One analogous marketing model is that used to inform consumers of the energy efficiency of some appliances, such as water heaters and refrigerators. In that context, consumers are now accustomed to pricing an appliance with its future costs in mind. The same could be applied to vehicles.

Since rates must be neither "excessive, inadequate, nor unfairly discriminatory,"⁴¹⁰ regulators and insurers will face some new challenges as these vehicles are introduced. Automobile insurance rates are based on extensive data bases. Apart from testing data, which may or may not be available to insurers or regulators (OEMs and others may treat this information as proprietary or trade secrets), there will be a considerable amount of guesswork going into initial rate making. At present, insurers have little or no data on which to base a rate, even assuming that it was clear where liability would lie.⁴¹¹

In addition, the added technology may raise repair costs. Perhaps they will be offset by lower frequency, perhaps not. Insurers would be inclined to play it safe by estimating higher rates, while regulators may be inclined to protect consumers and encourage adoption of this safer technology by estimating lower rates. Similar challenges have been confronted when new safety measures were introduced, such as rear window mounted taillights and electronic stability control. Some insurers are

⁴¹⁰ See, e.g., CAL. INS. CODE § 1861.05(a) (West 2013) ("No rate shall be approved or remain in effect which is excessive, inadequate, unfairly discriminatory or otherwise in violation of this chapter.")

⁴¹¹ Alexander C. Kaufman, *Tesla's Self-Driving Feature Leaves Insurers Idling as States Scramble*, HUFFINGTON POST (Mar. 28, 2015), http://www.huffingtonpost.com/2015/03/28/tesla-self-driving-cars_n_6961922.html.

working with OEMs to insure that they understand the new technology well enough to propose realistic insurance products and rates.⁴¹²

In time, there will be a growing database, however it will likely be much less static than databases used to rate current vehicles. OEMs will continually improve and update their algorithms, and these will be downloaded to all of the vehicles in the fleet. This could happen daily, or perhaps on a virtually continuous basis. As a consequence, yesterday's self-driving car will not be the same as today's or tomorrow's. In March 2015, Tesla downloaded over the web a revised algorithm to one of its models that increased its acceleration.⁴¹³ In the same month Tesla announced that it would, in 3 months, download a hands-free autopilot feature that would allow freeway driving without the driver's 100 percent attention.⁴¹⁴

Given the rapid advances of technology in other areas, one can expect the safety of these vehicles to rapidly improve. An insurance system that can respond to these improvements with similar alacrity will deliver numerous benefits. Many regulatory systems in prior approval states, however, are not presently equipped to quickly adjust rates. In California, for example, an insurer may not change a rate either up or down without filing a complete rate application.⁴¹⁵ Many other states allow some degree of flexibility without prior approval.⁴¹⁶ This regulatory challenge is only just beginning to be confronted.

3. Liability-Related Insurance Issues

Liability issues drive automobile insurance issues because a major function of automobile

⁴¹² See Cathy Schwamberger, Counsel for State Farm, Testimony before the California Department of Insurance (Sept. 15, 2014), <https://www.insurance.ca.gov/0400-news/multimedia/0030VideoHearings/upload/AVHearing-SchwambergerWrittenComments.pdf>.

⁴¹³ Jon Fingas, *Tesla Model S is getting even quicker through a software update*, ENGADGET (Jan. 29, 2015), <http://www.engadget.com/2015/01/29/tesla-model-s-acceleration-update/>.

⁴¹⁴ Although TESLA has since made it clear that driving is still the operator's responsibility. Evan Ackerman, *Tesla Model S: Summer Software Update Will Enable Autonomous Driving*, IEEE SPECTRUM (Mar. 23, 2015), <http://spectrum.ieee.org/cars-that-think/transportation/self-driving/tesla-model-s-to-combine-safety-sensors-to-go-autonomous>.

⁴¹⁵ CAL. INS. CODE § 1861.05(b) (West 2013) ("Every insurer which desires to change any rate shall file a complete rate application with the commissioner.").

⁴¹⁶ States allowing flex rating permit insurers to use new rates without prior approval if they do not exceed a certain percentage of the previously filed rate. See INSURANCE REGULATION, *supra* note 389, § 8.15. For a list of states and their regulatory frameworks, see *Regulation Modernization*, INS. INFO. INST. (Apr. 2015), <http://www.iii.org/issue-update/regulation-modernization>.

policies is to insure against liability of the insured or (in the case of uninsured/underinsured motorist coverage [UM/UIM]) the liability of another. Put another way, most of what insurers insure against today is human error. A typical insuring clause in the liability portion of a policy insures the "insured" for any amounts up to the policy limits for which the insured may become "legally liable." UM/UIM coverage compensates those injured by UM/UIM drivers up to the policy limits of the UM/UIM coverage only if the insured is "legally entitled to recover" from the uninsured or underinsured driver. Thus, legal responsibility is the lynchpin of both of these important coverages. To the extent human error is removed, to a similar extent the insurers' business model changes.

Driverless vehicles will challenge these traditional insurance models for several reasons. As vehicles move towards driverless capabilities, there will be a transitional period of shared driving experience—some driving in manual mode and some driving in self-driving mode. To the extent vehicles are driven in manual mode, one would expect liability and insurance to look much as it does at present. In order to accurately rate this portion of the driving, however, insurers will need to know how many miles the car is driven in manual mode and what the nature of this driving is (snow, urban, construction, etc.). Risks presented by these miles may differ substantially from the risks presented by average miles in general. In addition, gathering this information may present some privacy issues (discussed elsewhere in this report).

If the vehicle causes an accident while operating in driverless mode, under present products liability law the responsibility would be allocated to those in the commercial chain (dealer, OEM, possibly the programming entity if different, etc.) rather than the driver.⁴¹⁷ If the operator were sued, the automobile insurer would have a duty to defend under the policy. However, once it is shown that the operator was not "legally liable" for the accident, the traditional policy should not pay for the damages.

Autonomous cars could potentially lead to a substantial reduction in motor insurance claims if accidents significantly reduce in frequency. Lower claims would be expected to result in lower premiums, and tighter profit margins. Some might argue that if cars really do become crashless, there may not even be a need for motor insurance....Damage or theft can still occur when a car is parked in a driveway, and for the present at least, cars with semi-autonomous capabilities are more expensive than their traditional

⁴¹⁷ See *Fluor Co. v. Jeppesen & Co.*, 170 Cal. App. 3d 468, 216 Cal. Rptr. 68 (1985) (air chart treated as "product" when error in map contributed to crash).

counterparts. It is possible that this risk could become part of a household contents policy coverage.⁴¹⁸

Others believe that any significant impact on the insurance industry is far in the future.⁴¹⁹

Similarly, if a person were hit by a UM/UIM vehicle, there would be coverage if the uninsured or underinsured vehicle were driven in manual mode. If in driverless mode, however, then the injured party would not be “legally entitled to recover” from the operator of the uninsured or underinsured vehicle.⁴²⁰ Therefore, under present policies, the UM/UIM coverage would not apply. Rather than a UM/UIM claim against the insured’s own insurance company, the insured’s claim would be a products liability claim against the OEM and/or those in the commercial chain.

A product’s liability claim has the potential of being much more complex. As accidents increasingly become the responsibility of the commercial supplier, legislators and other policymakers may not be content to make every fender-bender a products liability case. Defense and cost containment expenses for different classes of claims differ dramatically. In 2013, insurers’ cost containment expenses for private passenger auto liability was 6.8 percent of incurred losses, while for products liability it was 75.1 percent.⁴²¹ One would expect similar expenses on the part of the injured party.

It may also present special challenges to the injured party if the manufacturer is no longer solvent

⁴¹⁸ LLOYD’S REPORT, *supra* note 404, at 18. Beginning in March 2015, some insurance companies began citing self-driving cars as threats to their business model in SEC filings. See Benjamin Preston, *Insurers Worry Self-Driving Cars Could Put a Dent in their Business*, THE GUARDIAN (Mar. 8, 2015), <http://www.theguardian.com/technology/2015/mar/08/insurers-worry-self-driving-cars-could-put-a-dent-in-their-business>. See also Kristen V. Brown, *Self-Driving Cars: Bumpy Ride for Insurance Industry*, S.F. CHRON. (Apr. 13, 2015) (citing four insurance companies that noted the potential threat of self-driving cars to their businesses), <http://www.sfgate.com/business/article/Self-driving-cars-bumpy-ride-for-insurance-6195316.php>.

⁴¹⁹ Mark Hollmer, *Progressive at PCI: Telematics will Become Ubiquitous Underwriting Tool*, CARRIER MGMT. (Oct. 28, 2014), <http://www.carriermanagement.com/news/2014/10/28/131022.htm> (quoting Tom Hollyer of Progressive Insurance as stating, “I don’t think there’s any kind of [auto]mobile insurance industry cliff in the foreseeable future.”).

⁴²⁰ A recent Farmers Insurance TV ad promoting UM/UIM coverage shows a robot driving a car into the rear of the insured’s parked car. The robot then runs away. Query as to whether the insured would have a claim against a robot driven car under UM/UIM insurance. Against whom would the insured be “legally entitled to recover?” The manufacturer of the robot? The car owner who, apparently, was a passenger in the car? The ad is available at <http://www.ispot.tv/ad/7fjV/farmers-insurance-robo-driver>.

⁴²¹ *Products Liability*, INS. INFO. INST. (2015), <http://www.iii.org/fact-statistic/products-liability>.

or available. Although “New GM” established a fund and process to compensate those injured by its defectively designed ignition switches, its official position is that it is not legally responsible for “Old GM’s” defective products. Although still subject to appellate review, a federal bankruptcy judge has ruled that those liabilities were discharged in bankruptcy.⁴²²

Every state has a guarantee fund to compensate, up to a limit, those who would be entitled to compensation should an insurance company become insolvent. These funds are funded by assessments on insurance companies admitted to sell insurance within the state. Unlike insurance companies, at present there is no guarantee fund to insure that those injured by insolvent OEMs are compensated.⁴²³ In addition, OEMs may choose to insure (if at all) with non-admitted, surplus lines insurers, risk retention groups, captives, or through other methods. Typically, guarantee funds do not back these liabilities.⁴²⁴

Given the shift in responsibility to the commercial marketers of driverless vehicles, one would also expect that the insurance burden (to the extent they choose to insure) would also shift to commercial policies covering dealers, OEMs, and others. Although physically injured parties may have claims against a number of parties in the commercial enterprise, the commercial parties may bargain to distribute any losses (which, with respect to them, are purely economic), among themselves as suits their commercial interests.⁴²⁵

4. Imposing Some or All of the Initial Liability on the Operator

To give an injured person a local and marginally solvent responsible party, it may be possible to make the vehicle’s performance a “non-delegable duty” for which the operator is responsible regardless of the lack of fault. There is some precedent for this

⁴²² Hilary Stout and Dannielle Ivory, *Ruling Shields G.M. From Ignition Suits*, N.Y. TIMES (Apr. 15, 2015), http://www.nytimes.com/2015/04/16/business/general-motors-wins-ruling-shielding-it-from-most-claims-over-ignition-flaw.html?_r=0. For a colorful commentary on this issue, see Further on the Effect of the GM Bankruptcy on New GM’s Exposure to Ignition Defect Litigation (June 5, 2014), <http://thenecessaryandproperblog.blogspot.com/2014/06/further-on-effect-of-gm-bankruptcy-on.html>. See also Linda Sandler and Patrick G. Lee, *Bankruptcy Order Could Shield GM from Ignition Switch Claims*, INS. J. (Mar. 20, 2014), <http://www.insurancejournal.com/news/national/2014/03/20/323778.htm>.

⁴²³ See INSURANCE REGULATION, *supra* note 389, § 12.12.

⁴²⁴ See *id.* § 12.13.

⁴²⁵ Philippine Airlines, Inc. v. McDonnell Douglas Corporation, 189 Cal. App. 3d 236, 234, 234 Call. Rptr. 423 (1987) (Airline and manufacturer allowed to allocate among themselves losses, including personal injuries, caused by crash).

approach with respect to brake failure.⁴²⁶ In the United Kingdom, liability falls on the driver/user even if not at fault. The driver's or insurer's remedy lies in subrogation against the manufacturer.⁴²⁷

If, however, unlimited liability remains on the operator for accidents caused by a failure of the product, many may be deterred from purchasing these safer vehicles. One possible compromise may be to fasten the initial responsibility on the operator up to the minimum financial responsibility limits set by the state. At present, drivers are required to carry insurance up to these modest limits. Fault on the part of the driver would be required for any claim beyond the minimum. This would give an injured party a convenient source for compensation for the majority of claims that fall within these limits without adding an additional burden on present drivers. Indeed, given the lower frequency of accidents, the premium may be substantially lower than at present.

If an insurer paid a claim for which its insured was not at fault, the insurer would have the right to pass the loss to the commercial suppliers through subrogation. Unlike the insured, it may be possible for insurers to consolidate similar claims against a manufacturer, thus making the processing of the claims much more efficient. Insurers and manufacturers may even find it in their interest to agree to arbitrate disputed claims. There is an existing model for mutual arbitration agreements. When an insurer pays a collision claim for which another insured may be responsible, insurers have agreed to arbitrate the claims with the responsible party's insurer.⁴²⁸ Likewise, uninsured/underinsured motorist claims are subject to arbitration.⁴²⁹ These claims are processed very quickly and at minimal expense. A similar model may emerge for dealing with subrogation claims. Insurers' rates should be net of any subrogation recovery (less expenses), so rates should still be lower than at present.

5. Product Liability and Higher Per Claim Costs

Under the present system, insurance payouts do not accurately reflect insurable losses. It is not uncommon for more serious injuries to go undercompensated because insurance coverage is inadequate to compensate for serious injuries. Setting aside possible coverage for health care costs from health insurance or public sources, if a

⁴²⁶ Maloney v. Rath, 69 Cal. 2d 442, 445 P. 2d 513 (1968) (faultless driver responsible for injury caused due to brakes negligently repaired by brake shop).

⁴²⁷ LLOYD'S REPORT, *supra* note 404, at 18–19.

⁴²⁸ See INSURANCE REGULATION, *supra* note 389, § 9.18.

⁴²⁹ See *id.* § 12.12.

responsible driver carries a minimal policy (e.g., 15/30/5 policy in California, another policy at a different state's minimum, or no insurance at all), a seriously injured party is likely to settle with the driver for far less than the party's actual injuries. Sadly, adequacy of compensation for serious injuries depends largely on the financial sufficiency of the injurer. If the injured party carries uninsured/underinsured motorist coverage (UM/UIM), there may be an additional source for compensation. UM/UIM coverage, however, is often modest in amount and is subject to numerous limitations. Many losses in serious cases, therefore, fall on the individual or on the public through such programs as Medicaid and Medicare.

In addition, there are exclusions in standard automobile policies which remove some otherwise insurable injuries from the insurance pool. For example, if a careless driver suffers injuries and also injures other family members in the vehicle, none of these injuries is covered. They fall within the "family" or "insured" (all relatives living in the home are "insureds") exclusion.

This dynamic changes dramatically if other sources of coverage or assets become available. As responsibility shifts from drivers to commercial suppliers, more injuries will be compensated at rates closer to their true value because commercial suppliers will have adequate assets or insurance. For example, if the driver and other family members were injured due to a defect in the automobile's ignition switch, all would have claims against the OEM. These injury costs will be passed to vehicle owners in the cost of the cars. Passing the true cost of a product, including injury costs, to those who use the product is one of the aims of "strict liability" under products liability tort law.⁴³⁰ It is also fairer to innocent injured parties if they must bear fewer of their injuries. It does mean, however, that the reduction in the frequency of accidents with self-driving cars may not net a linear savings to car owners. This is because injuries that would be under- or uncompensated when responsibility stops with the driver now will be compensated at closer to their actual value.

Claims costs may also rise because self-driving cars will likely be more expensive to repair. At the same time, however, costs attributed to assigning responsibility should decrease. Both California and Nevada require the event data recorder ("black box," or EDR) in self-driving cars to preserve all of the

⁴³⁰ Greenman v. Yuba Power Products, Inc., 59 Cal. 2d 57, 377 P. 2d 899 (1963); Phipps v. General Motors Corp., 278 Md. 337, 363 A. 2d 955 (Ct. App. 1976) (discussing the rationales for strict liability).

data for the last 30 seconds prior to an accident.⁴³¹ With some retraining, adjusters and lawyers should be able to assign responsibility among the driver, the vehicle, or others with relative ease.

Whether the higher claims value and higher repair costs will be offset by the lower claims frequency and lower adjustment costs remains to be seen.

6. Adoption of Self-Driving and Driverless Cars

For reasons stated above, the adoption of self-driving cars may present serious challenges to companies writing traditional personal automobile policies. The threat to their premium base and business model has been noted. At the same time, the public has much to gain by the adoption of self-driving cars. These challenges and benefits depend to a large extent on the rate at which self-driving cars are adopted.

The average life of a car in the current fleet is between 11 and 12 years (up from 9.8 years in 2002).⁴³² Thus, if all new cars were required to be self-driving cars, one would expect one-half of the fleet to be self-driving in approximately 11 years. Electronic Stability Control (ESC) has been required on all light vehicles since 2011, yet the Insurance Institute for Highway Safety (IIHS) and Highway Loss Data Institute (HLDI) estimate that there will not be 95 percent penetration of ESC until 2030.⁴³³ Since self-driving cars are not mandated and will not be available for several years, one might expect the penetration of self-driving cars to take even longer than ESC.⁴³⁴

There are some good reasons to believe that significant penetration may arrive sooner than these estimates. Safety features short of Level 3, such as ESC, do not drive the car to the extent that the driver may put driving time to other productive uses, whether that be texting, reading, or consulting with clients. Adding productive value to driving time

⁴³¹ CAL. VEH. CODE § 38750(c)(1)(G) (West 2014), NEV. ADMIN. CODE § 482A.110(2)(b) (2014). See also Majorie A. Shields, *Annotation, Admissibility of Evidence Taken from Vehicular Event Data Recorders (EDR), Sensing Diagnostic Modules, or "Black Boxes,"* 40 A.L.R. 6th 595 (2008). Privacy issues are discussed in Glancy, *supra* note 210, at 1175–76, 1202–03.

⁴³² *Average Age of Vehicles on the Road Remains Steady at 11.4 years, According to IHS Automotive,* IHS (June 9, 2014), <http://press.ihs.com/press-release/automotive/average-age-vehicles-road-remains-steady-114-years-according-ihs-automotive>.

⁴³³ See Adrian Lund, *Advanced Safety Technologies and Other Guideposts on the Road to Vision Zero* (June 5, 2014), <http://www.iihs.org/iihs/topics/presentations>. (Scroll down to June 5, 2014, and link to article.)

⁴³⁴ Hollmer, *supra* note 419 (It will be many years “before the new technology gets to even a 50 percent penetration of the install base.”)

should be a substantial incentive for many to adopt self-driving cars. This will especially be so if the insurance savings substantially offset the added cost of the self-driving components.

In a recent study by the Boston Consulting Group, their survey showed that, despite the added expense for the technology, 44 percent to 55 percent of those polled would buy either a partially or fully autonomous car. For partially autonomous cars, lower insurance costs were the top reason for making the purchase (safety was second). For fully autonomous cars, lower insurance was the second ranking reason, with safety in the first spot.⁴³⁵ Thus, properly rating these cars and passing the insurance savings on to the consumer will be critical to their rapid acceptance.

Since there are also benefits to the public in general (e.g., less congestion, fewer accidents, better fuel economy, etc.), it may be reasonable to view their adoption as a public good. As such, there will be sound reasons for public policymakers to offer incentives to adopt self-driving automobiles. Tax credits, as applied to electric vehicles, is one approach. Offering money to retire older cars (“Cash for Clunkers”) is already an incentive in place in some states. Air Quality Control Districts in California offer \$1,000 to retire older cars simply because they pollute more than newer ones. Driving in the carpool lane might also be offered as an incentive, along with, perhaps, a higher legal speed limit. Where trucks are currently limited to 55 mph and cars are limited to 65 mph, perhaps driverless cars, because of their enhanced safety features and better reactions, could be permitted an official 75 mph limit. There may be other incentives to more quickly introduce self-driving cars.

7. New Models of Insurance

As mentioned above, under the current legal regime, the role of traditional automobile liability insurance will decrease as the number and severity of accidents decreases and the legal responsibility for accidents shifts away from drivers or operators. Commercial insurance for those in the commercial chain will increase in importance. One would not expect this to present any special challenges, as commercial insurance has been available for thousands of products in the market place.

It is also possible that, at Level 4, many OEMs will not sell cars to individuals, but rather will sell them to operators of fleets of cars. Users will subscribe to use the vehicles as needed. One would expect the insurance burden, then, to fall on the commercial insurers of the OEM and/or the fleet owner.

⁴³⁵ BOSTON CONSULTING GROUP REPORT, *supra* note 188.

Depending on their business relationship, they could allocate this insurance burden among themselves.

If traditional products liability insurance is too expensive or unavailable, there is presently federal legislation in place to allow commercial entities to form associations to pool the risk themselves. In the 1970s, products liability insurance became very difficult to obtain. Congress responded by adopting the Product Liability Risk Retention Act of 1981⁴³⁶ and 1986.⁴³⁷ These acts allow OEMs, wholesalers, distributors, and retailers to form their own risk retention groups to spread and assume all of, or a portion of, their products liability exposure.⁴³⁸

This shift may create an opening for some new and innovative insurance products. Rather than pursuing a products liability claim against a commercial supplier, people may prefer to insure themselves against injury from driverless cars. Such a policy might resemble UM/UIM insurance (first-party insurance) or health insurance. The insured would have a claim against the insured's own insurance company. The difference would be that the ability to recover would not turn on whether the other driver was liable to the injured person (this will seldom be the case). A first-party claim may be far more convenient and efficient than pursuing a claim directly against the commercial suppliers of the vehicle. Health insurance, which may soon be ubiquitous, is of that kind. Even in the event of an automobile accident, the insured's health costs, less any deductibles or co-pays, are covered by the insured's own health insurer without regard to the legal responsibility of any other party. Indeed, health costs, which are often a significant part of an automobile accident injury claim, are covered regardless of fault. The health insurer, however, may or may not have a subrogation claim against the injuring party's recovery.⁴³⁹

If insurers were to employ the UM/UIM or health insurance model to offer a policy covering, for example, pain and suffering, it might be offered as a stand-alone policy or as an endorsement to some other existing policy (e.g., auto policy, homeowners policy, or rental policy).

8. Insure Like Online Ride Services?

There is an insurance model evolving in related vehicle transportation areas that lawmakers may

⁴³⁶ 15 U.S.C. §§ 3901 et seq. (2012).

⁴³⁷ 15 U.S.C. §§ 3901–3906 (2012).

⁴³⁸ See INSURANCE REGULATION, *supra* note 389, § 3.8.

⁴³⁹ For a recent decision discussing the controversial area of subrogation by a health insurer in the context of ERISA, see *Wurtz v. The Rawlings Co.*, 761 F.3d 232 (2d Cir. 2014). See also *U.S. Airways v. McCutchen*, ___ U.S. ___, 133 S. Ct. 1537, 185 L. Ed. 2d 654 (2013) (self-funded ERISA plan entitled to recover health expenditures from injured party, including injured party's UM/UIM coverage).

easily adapt to self-driving cars. When a car is being driven in self-driving mode, the person who would ordinarily have been the "driver" is really no more than a passenger. The car is driven by the algorithm built into the car's computer system and by any updates. This is analogous to riding in a taxi or limousine driven by someone else. Imagine a robot sitting in the driver's seat. Most, and perhaps all, states regulate the insurance requirements for taxis, limousines, and (now) online ride services (also known as Transportation Network Companies [TNCs] such as Uber and Lyft). In April 2015, approximately 35 states had TNC legislation either enacted or pending.⁴⁴⁰

California enacted its own statute.⁴⁴¹ This legislation submits regulation of TNCs to the California Public Utilities Commission (CPUC), but also sets minimum insurance requirements below which the CPUC may not go. The statute requires a minimum of \$1 million in liability and uninsured motorist coverage when a passenger is in the car; it requires \$1 million in liability coverage from the time the driver accepts a passenger; and it requires \$250,000 in coverage (\$50,000 primary and \$200,000 "excess") from the time the driver turns on the app which allows potential passengers to solicit rides from the driver.

To the extent driverless cars are deployed in fleets, either by the OEM or others, this model may commend itself. California's current TNC statute applies only to businesses connecting passengers with drivers using their "personal vehicles."⁴⁴² Therefore, it may not be broad enough to cover driverless cars deployed on a fleet basis. A fleet may, however, fall within the jurisdiction of the CPUC as a "charter party carrier." A charter party carrier includes "...every person engaged in the transportation of persons by motor vehicle for compensation, whether in common or contract carriage, over any public highway in this state."⁴⁴³

To the extent the cars are privately owned, similar insurance might be offered on a group basis.⁴⁴⁴ The group would be those who own the vehicles and those related to the owner in much the same way

⁴⁴⁰ ISO Introduces Endorsements to Address Ridesharing Policy Gaps, Ins. J. (Apr. 2, 2015), <http://www.insurancejournal.com/news/national/2015/04/02/363254.htm>.

⁴⁴¹ CAL. PUB. UTIL. CODE §§ 5430–5443 (West 2010 & Supp. 2015).

⁴⁴² *Id.*

⁴⁴³ *Id.* § 5360.

⁴⁴⁴ The California Insurance Code states that "Any insurer may issue any insurance coverage on a group plan, without restriction as to the purpose of the group, occupation or type of group." CAL. INS. CODE § 1861.12 (West 2013). At this writing, the California Commissioner of Insurance is studying the possibility of narrowing the definition of "group" under this provision. Whether owners of self-driving or driverless cars may qualify as a "group" is at present an open question.

that private auto insurance covers family members, permissive users, and others.

9. Cyber Insurance

Cyber risks from hackers have become all too familiar as the personal and commercial world becomes ever more connected. Driverless cars may raise the importance of cybersecurity because, unlike most hacking today, malicious cyber interference with an automobile may cause serious personal injury and property damage.⁴⁴⁵ At present there is little financial motive to hack into cars, but this may change.⁴⁴⁶ As a consequence, NHTSA is doing focused research on hacking and hacking defenses at its Transportation Research Center.⁴⁴⁷

In addition, the vehicle, or its manufacturer, may acquire data of a personal privacy nature. These dangers would suggest that there may be an evolving market, at least at the commercial level, for cyber insurance policies to cover these enhanced risks.⁴⁴⁸

There is considerable doubt whether standard Commercial General Liability (CGL) policies cover cyber risk. The issue may turn on whether there was “property damage” or merely damage to electronic media and records. In any event, insurers are beginning to add cyber exclusions to the policies to avoid any ambiguity with respect to the issue.⁴⁴⁹

⁴⁴⁵ Three recent “friendly” hacking experiences have been widely reported. In one case the hacker hacked into a commonly used dongle of the kind supplied by insurance companies and others to monitor driving. Andy Greenberg, *Hackers Cut a Corvette’s Brakes Via a Common Car Gadget*, WIRED (Aug. 11, 2015), <http://www.wired.com/2015/08/hackers-cut-corvettes-brakes-via-common-car-gadget/>. In another, hackers took over the steering of a jeep. Greenberg, *supra* note 194. The third incidence was the hacking into a TESLA. Kim Zetter, *Researchers Hacked a Model S, But Tesla’s Already Released a Patch* (Aug. 6, 2015), <http://www.wired.com/2015/08/researchers-hacked-model-s-teslas-already/>. Tesla claims to have fixed the vulnerability with a download. These all were friendly hacks, in the sense that those who did them were merely demonstrating to the industry the vulnerability without malicious intent.

⁴⁴⁶ One study reported that a disgruntled employee used a Web-based system to immobilize approximately 100 cars and leave them with their horns honking. Dowling & Partners Securities, LLC, Property and Casualty Research, *It’s Been A Great Ride...*, (Sept. 27, 2013), at 13.

⁴⁴⁷ Jim Travers, *Inside the Government Lab Hacking Into Cars*, CONSUMER REPORTS (May 7, 2015), <https://www.yahoo.com/autos/inside-the-government-lab-hacking-into-cars-118366695712.html>. See also *Can Your Car Get Hacked? Your Driving Data Is At Risk. Someday, Your Car’s Controls Could Be As Well*, CONSUMER REPORTS (Apr. 30, 2015), <http://www.consumerreports.org/cro/magazine/2015/06/can-your-car-get-hacked/index.htm>.

⁴⁴⁸ LLOYD’S REPORT, *supra* note 404, at 16–20.

⁴⁴⁹ Judy Greenwald, *Insurers fight to bar cyber coverage under commercial general liability policies*, BUS. INS. (Oct. 26, 2014), <http://www.businessinsurance.com/article/20141026/NEWS07/141029850>.

10. Telematics-Based Policies

As OEMs become increasingly responsible for driving cars, they will need to gather information about how and where the car is driven. This information may be used to improve programming, avoid misuse, and achieve overall safety for those in the vehicle and others. This information may also be useful to improve insurance products.

Ideally, an insurer would rate a policy based on real knowledge about the driver, the vehicle, and other hazards that it might present. It is impractical, however, to put an observer in every vehicle, so insurers instead rely on “proxies”—e.g., driving record, age, gender, location, vehicle type, etc. These are the familiar rating factors used to price policies.

With the new information flowing back and forth between the driver and the OEM, it may be possible to price policies so that the premiums better match the actual exposure. Proxies are, after all, only very rough approximations of risk. OEMs may find it in their interest to offer their own policies, or they may share this information with affiliated insurers.

Use of this information for other than improving the safe driving of the vehicle may cause serious privacy concerns. At present a number of insurers offer telematics-based policies on an optional (i.e., opt-in) basis.⁴⁵⁰ Even with an opt-in, however, California’s commissioner of insurance has not approved collection of any data by insurers beyond mileage.⁴⁵¹ In a November 12, 2014, letter to the Federal Trade Commission, a number of OEMs pledged not to pass on information to insurers and others without the owner’s permission.⁴⁵²

11. The Future of Mandatory Automobile Insurance

As the dangers of automobiles became apparent, many states adopted some form of mandatory insurance (usually known as Financial Responsibility Laws, or FR). Having in mind that at one time automobiles were causing approximately 55,000 fatalities per year in the United States, some form of mandatory coverage seemed imperative. Eventually every state except New Hampshire adopted some form of mandatory automobile insurance, along with some form of either mandatory or optional UM/UIM insurance.

⁴⁵⁰ Mark Hollmer, *Progressive at PCI: Telematics will Become Ubiquitous Underwriting Tool* (Oct. 28, 2014), <http://www.carriermanagement.com/news/2014/10/28/131022.htm>.

⁴⁵¹ CAL. CODE REGS. tit. 10, § 2632.5(i)(5)(a) (2015) (“An insurer shall only use a technological device to collect information for determining actual miles driven....”). See also LLOYD’S REPORT, *supra* note 404, at 18.

⁴⁵² Joan Lowy, *Automakers Vow to Protect Motorists’ Privacy*, SAN JOSE MERCURY NEWS (Nov. 13, 2014), http://www.mercurynews.com/drive/ci_26929248/automakers-vow-protect-motorists-privacy.

Much has changed since those days. With far greater population, far more cars, and far more miles driven, the rate of fatalities has declined to approximately 33,000 per year.⁴⁵³ This is still a significant number. Over 10 years this is 40,000 more deaths than the population of Saint Paul, Minnesota. Nevertheless, the introduction of self-driving cars offers the prospect of dramatically reducing this toll, along with the related injury rate.

This raises the question whether it will be necessary to continue mandatory automobile insurance requirements.⁴⁵⁴ Although many choose to insure against liability for non-auto related injuries, usually through endorsements on their homeowners or renters policy, there is no requirement that they do so even though they may engage in any number of dangerous activities. Accidents arising from boating, ATVs, firearms, scalding water, power tools, play equipment, swimming pools, lawnmowers, and many other hazards are but a few examples.

F. Connected Vehicle Communications Issues

Looking further into the future, there will likely be a time when connected vehicle communications (perhaps V2V or V2I) play a very important role in transportation and road safety.

Once most or all cars are communicating with one another, it may be almost impossible to assign responsibility for any particular accident. This will especially be so if they communicate in an anonymous manner to protect the privacy of their passengers. Moreover, even if assigning responsibility were possible, it may not be worth the effort. This would suggest that it may be appropriate to consider an entirely different compensation and/or insurance system for those, hopefully rare, accidents. Since the many benefits flowing from such an integrated system accrue not only to the individual driver, but the public in general, policymakers may explore more publicly oriented compensation methods. As discussed in Section IV, infra, one possible model is that designed for the rare adverse side effects that flow from vaccines. A \$0.75 tax on each dose of the vaccine funds the National Vaccine Injury Compensation Program.⁴⁵⁵ Within some limits, those injured by vaccines may recover for their injuries without showing fault, defect, or any other responsibility

⁴⁵³ See Adrian Lund, *Advanced Safety Technologies and Other Guideposts on the Road to Vision Zero* (June 5, 2014), <http://www.iihs.org/iihs/topics/presentations> (Scroll down).

⁴⁵⁴ LLOYD'S REPORT, *supra* note 404, at 18; Stephanie K. Jones, *Future Visions: Will Driving Become Too Safe to Insure*, INS. J. (May 8, 2012), <http://www.insurancejournal.com/news/national/2012/05/08/246831.htm>.

⁴⁵⁵ National Childhood Vaccine Injury Act of 1986, 42 U.S.C. §§ 300aa-1 to 300aa-34 (2012).

other than cause. The program is administered by the Federal Court of Claims.⁴⁵⁶

G. Some Different Models for Compensating Those Injured by Driverless Vehicles

Automobile insurance is not the only way to protect the public with respect to accidents. Automobiles are “Goods” under the Uniform Commercial Code and they are “Products” for products liability purposes. Apart from any express warranties, as goods they come to the consumer with implied warranties of merchantability and fitness for purpose. As products, they must be free of defects in design and manufacture (including, in California, satisfying the reasonable expectations of a consumer).⁴⁵⁷ In addition, they must be accompanied by adequate warnings. Moreover, claims under the UCC and products liability may be asserted against the OEM and all in the commercial chain of distribution.⁴⁵⁸ This may include the entity programming the “map” for the vehicle.⁴⁵⁹

These rules were developed for the purpose of protecting consumers in much the way insurance protects the consumer. They also fold the costs of injuries into the cost of the goods, thus encouraging the development of safer goods and influencing rational consumer choices by reflecting injury costs in the price.

Since those in the commercial chain are likely to be responsible for injuries caused by driverless cars, one would expect funding this liability will shift also to the business judgment of those in the chain. OEMs, for example, may self-fund, retain some of the risk, insure, insure through a captive, or adopt some other model. Since some surveys suggest that drivers believe that they are safer than a self-driving car, marketing self-driving cars with an express warranty of their safety may be an effective marketing tool. If the OEM “owns” the responsibility anyway, there would be little additional cost to them in making their existing responsibility express.

In addition, it is unlikely that purchasers of automobiles will own the software that drives the car. Like most other computer programs, ownership will

⁴⁵⁶ See Kevin Funkhouser, *Paving the Road Ahead: Autonomous Vehicles, Products Liability, and the Need for a New Approach*, 2013 UTAH L. REV. 437 (2013) (arguing for a no-fault scheme modeled after the federal National Childhood Vaccination Injury Act.)

⁴⁵⁷ Campbell v. General Motors Corp., 32 Cal. 3d 112, 124–27, 649 P.2d 224, 231 (1982).

⁴⁵⁸ Henningsen v. Bloomfield Motors, Inc., 32 N.J. 358, 161 A.2d 69 (1960).

⁴⁵⁹ See Fluor Co. v. Jeppesen & Co., 170 Cal. App. 3d 468, 216 Cl. Rptr. 68 (1985) (treating an air chart as a “product” when an error in the map contributed to a crash).

remain in the OEM, and the program will be licensed to the operator.⁴⁶⁰ In order to keep mapping and algorithms up to date, there will be a constant flow of information between the supplier and the self-driving car. Although there will be some privacy concerns, some flow in information will doubtless be necessary in order to keep driverless cars as safe as they may reasonably be made.

Licensing, rather than selling, the programs also helps address a separate issue—how to address aging technology. Computers, including personal computers, age and become outdated even with the benefit of updates. Although many cars sold today will run for 20 years, it is doubtful that the technology behind a self-driving car will last that long. Ownership of the program by the OEM will allow the OEM to “retire” dated technology. The OEM could disable technology that is not updated or has become inadequate. This may compel the owner to return to the dealer for the installation of a new processor or program, or return the car to manual mode, or, perhaps, force retirement of the vehicle (with some attendant marketing issues presented by forced retirement). To the extent that driverless cars are marketed on a fleet basis with subscriptions, their constant use will make earlier retirement more economical.

H. Guarantee Funds for OEMs

Assuring the solvency of insurers is a primary function of state insurance regulators. When an insurer becomes insolvent, all states also have guarantee funds covering some of the liability for insolvent insurers (see discussion above). Guarantee funds usually have caps on coverage—e.g., \$500,000 in California, although the guarantee is unlimited for workers’ compensation claims.

There is no similar guarantee fund for suppliers of automobiles. As responsibility for injuries shifts from drivers to OEMs and others in the commercial chain, injured parties must look there for compensation. The financial condition of those in the commercial chain is not regulated or vetted like insurance companies. There are any number of auto manufacturers who have disappeared, and even the well-known brand, General Motors, is no longer the same company that bore that name a few years ago. There are also mergers and acquisitions that will raise questions of responsibility for injuries.

⁴⁶⁰ Kyle Wiens, *We Can’t Let John Deere Destroy the Very Idea of Ownership*, WIRED (Apr. 21, 2015), <http://www.wired.com/2015/04/dmca-ownership-john-deere/> (noting that with the exception of Tesla, automakers and even manufacturers of farm machinery assert ownership over the software in their products).

This raises the question whether it would be in the public interest to look into ways to guarantee some protection when injured parties may no longer look to the commercial chain for compensation. Much like the National Vaccine Injury Compensation Program, it might be funded with an assessment on sales or licenses. Regulations for the testing of self-driving cars in California, Florida, and Nevada have taken a small step in that direction. Testers must maintain \$5 million in insurance, bonds, or audited net worth in order to test self-driving cars on California’s public roads.⁴⁶¹

I. Example of Awkward State Insurance Regulation—California’s Proposition 103

California is the largest insurance market in the United States and also has the largest number of cars on the road of any state. It also presents an interesting case study illustrating how state regulation of insurance may have unintended consequences for insuring driverless cars.⁴⁶²

In 1988, when driverless cars existed only in science fiction, California voters adopted Proposition 103. Unlike ordinary legislation, the proposition may be amended only by a 2/3 vote of the legislature, and then only if the changes “further” the purposes of the proposition. Otherwise, it may only be amended by another proposition adopted by the voters.

Proposition 103 changed the regulation of insurance in a number of significant ways. Like a number of states, the proposition made automobile rates subject to “prior approval.” The proposition also mandated that three rating factors must be weighted higher than any others (including the capabilities of the vehicle) and in the following order:

1. Driver’s driving record (e.g., accidents and convictions for moving violations);
2. The number of miles driven per year; and
3. The number of years of driving experience.⁴⁶³

In addition to mandating that a driver’s driving record and years of driving experience be weighted more than any other rating factor, Proposition 103 also requires all auto insurers to offer a “Good Driver

⁴⁶¹ CAL. VEH. CODE § 38750(b)(3) (2014); FLA. STAT. § 316.86 (2015); NRS § 482A.060 (2015).

⁴⁶² Robert W. Peterson, *New Technology—Old Law: Autonomous Vehicles and California’s Insurance Framework*, 52 SANTA CLARA L. REV. 1341 (2012); Hilary Rowan, “Out-of Date Rating Factors May be Impediment to Self-Driving Cars,” DAILY JOURNAL (San Francisco, CA), Nov. 12, 2014, at 1.

⁴⁶³ CAL. INS. CODE § 1861.02(a) (West 2013). In contrast to personal automobiles, the mandatory rating factors would not apply to automobiles deployed on a fleet basis because they do not apply to any policy insuring more than four vehicles. *Id.*, § 660(a)(2).

Discount.” Insurers are to offer those who qualify a discount of “at least 20% below the rate the insured would otherwise have been charged for the same coverage.”⁴⁶⁴

Proposition 103 also does not allow insurers to change a rate (either up or down) without filing a “complete rate application.”⁴⁶⁵ Driverless cars, which are really computers with wheels, are likely to improve in safety at a rate more consistent with computer development than with Detroit design. Accidents, and perhaps near accidents, can be analyzed, the algorithm can be adjusted, and it can be downloaded to every vehicle in the fleet.⁴⁶⁶ Although insurance regulators attempt to insure that rates are not excessive, inadequate, or unfairly discriminatory, unlike California, a number of states allow some degree of flexing up or flexing down without prior approval. This is usually within a range of 5 percent, 7 percent, or 15 percent.⁴⁶⁷

On September 15, 2014, the California Department of Insurance held its first hearing to begin to address some of these issues.⁴⁶⁸

J. Conclusions

Whether rating driverless cars under a personal liability regime or a products liability regime, insurers will be challenged by lack of data. Testing data and simulations are helpful, but they are a poor substitute for actual data generated by the driving of these vehicles in the hands of the public.

Much of this data, such as it is, may be reported (as in California) to the DMV under its testing regulations, but it may not be available to insurers or others because it is considered proprietary by those reporting. Some insurers are working closely with product

⁴⁶⁴ *Id.*, § 1861.02(b)(2).

⁴⁶⁵ *Id.*, § 1861.05(b) (“Every insurer which desires to change any rate shall file a complete rate application with the commissioner.”).

⁴⁶⁶ Evan Ackerman, *Why You Shouldn’t Worry About Self-Driving Car Accidents*, IEEE SPECTRUM (May 12, 2015), <http://spectrum.ieee.org/cars-that-think/transportation/self-driving/why-you-shouldnt-worry-about-googles-selfdriving-car-accidents> (“The specific cause of the accident could then be identified, and then, more than likely, engineers could develop a way of making sure that the car would never, ever have that accident again. Furthermore, the update could be instantly propagated to every other autonomous car, making them all that much safer. Needless to say, humans don’t work this way, and we just keep having the same sorts of accidents over and over again.”).

⁴⁶⁷ A list of states and their regulatory framework appears at *Regulation Modernization*, INS. INFO. INST., <http://www.iii.org/issue-update/regulation-modernization>.

⁴⁶⁸ For a report of the hearing, see Don Jergler, *Prop. 103 vs. Self-Driving Cars Revving Up in California*, INS. J. (Sept. 18, 2014), <http://www.insurancejournal.com/news/west/2014/09/17/340898.htm>.

developers to develop a sufficient understanding of the technology and the risks to make an educated guess at appropriate rates. It might be helpful to insurers, and regulators who must assure that rates are not excessive, inadequate, or unfairly discriminatory, if the insurance industry were more closely integrated in the development and approval process.

As driverless cars move into the market place, they will begin to generate frequency and severity data. Unlike data generated from manually driven vehicles, the credibility of this data may rapidly change. The programs, algorithms, and maps driving the automobiles are likely to be updated frequently, or, perhaps, continuously. Thus, yesterday’s rates may no longer be appropriate for tomorrow’s vehicle. Assuming that driverless cars will prove much safer than manually driven cars, reducing the insurance burden on owners should increase acceptance of the vehicles. Unfortunately, the regulatory systems of many states, including California, are not geared to nimble rate adjustments. Some states do, however, allow insurers to flex within a range without approval.

While lower frequency and ease of assigning responsibility because of information stored in the event data recorder should push rates lower, two factors push in the opposite direction. As responsibility moves from individuals (who may be uninsured or underinsured) to the commercial side, the more serious injuries are likely to be adjusted at closer to their actual value. In addition, driverless cars may be more expensive to repair. How these two vectors will interact remains to be seen.

California is in a unique position because of Proposition 103. Proposition 103 is driver-centric, not vehicle-centric. Two of the three mandatory rating factors (driving record and years of driving experience) assume that there is a driver who is legally responsible for operating the vehicle. Likewise, the Good Driver Discount assumes that there is a driver who, if good, deserves the discount, and if “not good,” then not. These rating factors and the Good Driver Discount would do little mischief if they were not mandatory. How this regulatory system will accommodate driverless cars is an open question.

In the more distant future, as self-driving cars begin to dominate the market, the public may prefer to insure itself against injuries caused by faulty cars and faultless drivers. There may be a market for first party insurance (something like UM/UIM) to compensate for these kinds of claims. Health care costs, which are a large part of claims for more serious injuries, are already of this kind.

As we move even further into the future, it is likely that automobiles will both communicate with each other (V2V) and communicate with the

infrastructure (V2I). With dozens of cars communicating with each other, when an accident does occur in this space, it may be impossible to resolve fault, or even cause. It may be appropriate, then, to move to an entirely different system for compensating injuries. Something along the lines of the National Vaccine Injury Compensation Program may be appropriate.

VII. PRIVACY AND SECURITY LAWS

Privacy and security laws will affect the design and operation of driverless vehicles both on the road and as part of the cyber infrastructure. These laws include measures protecting personal information, regulating surveillance, preventing interference with personal choices, as well as requiring physical, network, and information security requirements.

Ultimately, a wide variety of privacy and security laws are certain to apply to driverless vehicles. At present, privacy laws are numerous and varied. Security laws are less developed. Increased complexity with regard to both applicable privacy laws and security requirements is nearly certain by the time driverless vehicles are in widespread use.

A. Expectations of Privacy in Driverless Vehicles

Driverless vehicle users will expect that both privacy and security will be protected when they use driverless vehicles. In an era in which vehicles are often associated with surveillance, car hacking, targeted advertising, privacy breaches, and Big Data, legal protection for privacy expectations in driverless vehicles will depend in part on the extent to which courts and legislatures recognize such privacy expectations as reasonable.

“Reasonable expectation of privacy” expresses a norm used to determine whether privacy protections should apply in a wide variety of legal contexts from criminal procedure⁴⁶⁹ to tort law,⁴⁷⁰ as well as in statutes⁴⁷¹ and administrative regulations.⁴⁷² The modern legal concept of reasonable expectations of privacy is usually based on the 1967 United States Supreme Court decision, *Katz v. United States*,⁴⁷³ in which the

⁴⁶⁹ See text accompanying notes 355–378, *supra*.

⁴⁷⁰ See e.g., *Sanders v. Am. Broad. Co.*, 20 Cal. 4th 907, 978 P.2d 67, 85 Cal. Rptr. 2d 909 (1999) (discussing privacy expectations of a car crash victim).

⁴⁷¹ For example, the federal Foreign Intelligence Surveillance Act, 50 U.S.C. § 1801 (2012) and California’s version at § 1708.8 of the California Civil Code, CAL. CIV. CODE § 1708.8 (West 2009).

⁴⁷² Department of Homeland Security Regulations that Support Anti-Terrorism by Fostering Effective Technologies, 6 C.F.R. §§ 25.1–25.9 (2012).

⁴⁷³ 389 U.S. 347, 88 S. Ct. 507, 19 L. Ed. 2d 576 (1967). Katz excluded from evidence in a criminal prosecution defendant’s conversations recorded by law enforcement from outside a public phone booth located on a public street.

court ruled that the Fourth Amendment’s search and seizure restriction “protects people, not places.”⁴⁷⁴ *Katz* and decisions following it suggest that the privacy expectations of people using driverless vehicles would be protected under the Fourth Amendment.

Although older court decisions sometimes described privacy expectations of people in motor vehicles as ranging from very low to virtually absent,⁴⁷⁵ people in vehicles do have constitutionally protected reasonable expectations of privacy. In *Delaware v. Prouse*⁴⁷⁶ the U.S. Supreme Court observed,

An individual operating or traveling in an automobile does not lose all reasonable expectation of privacy simply because the automobile and its use are subject to government regulation. Automobile travel is a basic, pervasive, and often necessary mode of transportation to and from one’s home, workplace, and leisure activities. Many people spend more hours each day traveling in cars than walking on the streets. Undoubtedly, many find a greater sense of security and privacy in traveling in an automobile than they do in exposing themselves by pedestrian or other modes of travel. Were the individual subject to unfettered governmental intrusion every time he entered an automobile, the security guaranteed by the Fourth Amendment would be seriously circumscribed. As [this Court has] recognized, people are not shorn of all Fourth Amendment protection when they step from their homes onto the public sidewalks. Nor are they shorn of those interests when they step from the sidewalks into their automobiles.⁴⁷⁷

In Fourth Amendment cases, this reasonable expectation of privacy in vehicles is subject to a number of exceptions to the usual search warrant requirements, as discussed above in Section V.B. In evaluating the reasonableness of privacy expectations, vehicles on roads are frequently contrasted with homes, where privacy expectations are very high,⁴⁷⁸ as if vehicles and homes were at opposite ends of a wide spectrum of reasonable expectations of privacy. However, that does not mean that individuals’

⁴⁷⁴ *Id.* at 351–52. The Supreme Court rejected basing Fourth Amendment warrant requirements solely on location and interference with property rights. Although the defendant’s conversations took place in a public location, the Court insisted “what he seeks to preserve as private, even in an area accessible to the public, may be constitutionally protected.” *Id.* The “reasonable expectations of privacy” analysis was suggested by Justice Harlan in his concurring opinion.

⁴⁷⁵ See *United States v. Knotts*, 460 U.S. 276, 103 S. Ct. 1081, 75 L. Ed. 2d 55 (1983). The Supreme Court in *United States v. Jones*, ___ U.S. ___, 132 S. Ct. 945, 181 L. Ed. 2d 911 (2012), distinguished *Knotts* as limited to “beeper” technology. *Jones*, 132 S. Ct. at 951–52.

⁴⁷⁶ *Delaware v. Prouse*, 440 U.S. 648, 99 S. Ct. 1391, 59 L. Ed. 2d 660 (1979).

⁴⁷⁷ *Id.* at 662–63.

⁴⁷⁸ *Kyllo v. United States*, 533 U.S. 27, 121 S. Ct. 2038, 150 L. Ed. 2d 94 (2001) (involving the use of a thermal imaging device from a public vantage point to monitor the radiation of heat revealing a marijuana growth inside a person’s home).

expectations of privacy in driverless vehicles are unreasonable or unworthy of legal protection.⁴⁷⁹

After *Prouse*, in *Indianapolis v. Edmond*,⁴⁸⁰ the United States Supreme Court decided that, absent a judicial warrant, stopping every vehicle on a roadway for general law enforcement purposes constitutes an unreasonable seizure for the purposes of the Fourth Amendment.⁴⁸¹ According to the Court, part of the purpose of the Fourth Amendment is to protect political liberty. The Court said that the Fourth Amendment “draw[s] the line at roadblocks designed primarily to serve the general interest in crime control,” because such indiscriminate searches represent a dangerous step toward authoritarian government.⁴⁸²

Later, in *Arizona v. Gant*,⁴⁸³ Justice Stevens warned against “undervalu[ing] the privacy interests at stake. Although we have recognized that a motorist’s privacy interest in his vehicle is less substantial than in his home,” the privacy interest of motorists “is nevertheless important and deserving of constitutional protection.”⁴⁸⁴ The Court expressly rejected “[a] rule that gives police the power to search a vehicle whenever an individual is caught committing a traffic offense, when there is no basis for believing evidence of the offense might be found in the vehicle.”⁴⁸⁵ A rule allowing such a search would be unacceptable because it “creates a serious and recurring threat to the privacy of countless individuals.”⁴⁸⁶ People who use driverless vehicles should enjoy similar privacy protections against unreasonable searches of their vehicles.⁴⁸⁷

Since then, in *United States v. Jones*,⁴⁸⁸ the United States Supreme Court protected privacy interests in data about a vehicle-user’s movement from place to

⁴⁷⁹ Dorothy J. Glancy, *Privacy on the Open Road*, 30 OHIO N. U. L. REV. 295, 295–99 (2004).

⁴⁸⁰ *Indianapolis v. Edmond*, 531 U.S. 32, 121 S. Ct. 447, 148 L. Ed. 2d 333 (2000).

⁴⁸¹ *Id.* at 48.

⁴⁸² *Id.* at 42.

⁴⁸³ *Arizona v. Gant*, 556 U.S. 332, 344, 120 S. Ct. 1710, 173 L. Ed. 2d 485 (2009). The case involved a vehicle search incident to an arrest.

⁴⁸⁴ *Id.* at 344.

⁴⁸⁵ *Id.*

⁴⁸⁶ *Id.*

⁴⁸⁷ Since under *Katz*, “people not places” are protected under the Fourth Amendment, a driverless vehicle not associated with people would not be accorded similar privacy protection.

⁴⁸⁸ *United States v. Jones*, __ U.S. __, 132 S. Ct. 945, 181 L. Ed. 2d 911 (2012). The Court’s decision in *Jones* held that a Fourth Amendment “search” occurred when law enforcement agents attached a tracking device to a vehicle and then used the device remotely and continuously to follow a suspect’s vehicle on public roadways. *Id.*, 132 S. Ct. at 949.

place. One of the central issues posed in *Jones* was whether the defendant had reasonable privacy expectations protected by the Fourth Amendment as he drove his wife’s car around the Washington, D.C., area for a month with a hidden government-installed GPS tracking device capturing every move the vehicle made. The decision in *United States v. Jones* suggests that, unless a warrant is first secured, remote tracking of a driverless vehicle would interfere with reasonable expectations of privacy protected under the Constitution.⁴⁸⁹ Intrusions into a driverless vehicle’s internal systems to collect evidence of criminal activity would also appear to deserve similar Constitutional censure.⁴⁹⁰

Recent court decisions interpreting the Fourth Amendment have paid increasing attention to enhanced expectations of privacy in the contexts of roadways,⁴⁹¹ of vehicles,⁴⁹² and of technologically enhanced searches.⁴⁹³ Since driverless vehicles will involve all of these contextual factors, privacy expectations in driverless vehicles are probably reasonable.

B. Privacy Laws

Although privacy laws may change somewhat by the time driverless vehicles become available, laws protecting personal information and communications, as well as controlling surveillance, will protect the privacy of people using driverless vehicles.

1. Personal Information Privacy Laws

A growing number of personal information laws will apply to driverless vehicles.⁴⁹⁴ In particular, driverless passenger cars that transport individual people will inevitably generate considerable personal information. Examples of personal information associated with driverless passenger vehicles will include information about vehicle ownership, registration, and vehicle insurance information. Driverless passenger cars will generate real-time location information about people using driverless cars, as well as records of past travel patterns.

⁴⁸⁹ In a later decision involving a warrantless search of a smart phone, Chief Justice Roberts, writing for a unanimous court, emphasized that expectations of privacy are enhanced by the scale and pervasiveness of personal information revealed. *Riley v. California*, __ U.S. __, 134 S. Ct. 2473, 189 L. Ed. 2d 430 (2014).

⁴⁹⁰ See *Jones*, 132 S. Ct. at 958 (Alito, J., concurring). The concurring opinions in *Jones* are particularly emphatic about this point.

⁴⁹¹ E.g., *Gant*, 556 U.S. 332.

⁴⁹² E.g., *Jones*, 132 S. Ct. 945.

⁴⁹³ E.g., *Kyllo*, 533 U.S. 27.

⁴⁹⁴ See Glancy, *Privacy in Autonomous Vehicles*, *supra* note 210, at 1173–78 (providing an extended analysis of these laws).

Other types of driverless vehicles, such as trucks and buses, may generate somewhat less private data about specific human persons and more data about corporations or other entities that own or use these driverless vehicles.

a. Drivers Privacy Protection Act.—One of the federal privacy statutes that will govern personal information associated with driverless vehicles is the federal Drivers Privacy Protection Act (known as the DPPA).⁴⁹⁵ This federal statute protects an individual's personal information contained in motor vehicle registration and licensing records held by state motor vehicle departments (DMVs).⁴⁹⁶ Disclosure of DMV personal information without the written consent of the subject of the information is prohibited unless an exception applies. This federal law regulating the privacy of DMV vehicle records will apply to owners of driverless vehicles licensed and registered by state departments of motor vehicles.

In 2013 the United States Supreme Court reaffirmed the importance of privacy protection provided by the DPPA in a case involving plaintiffs' lawyers who improperly obtained North Carolina DMV registration records containing vehicle purchasers' names and addresses. The lawyers illegally used that information to send direct mail advertisements to potential plaintiffs in a class action against vehicle dealers.⁴⁹⁷

A number of states have enacted laws similar to the DPPA to protect personal information held by their departments of motor vehicles even more extensively than DPPA.⁴⁹⁸ It is possible that these laws could be extended also to protect information of people who use driverless vehicles, if records of such driverless vehicle use (for example in driverless vehicle ride services) are required to be maintained by state departments of motor vehicles. Drivers required to be present in test versions of driverless vehicles, as well as persons involved in collisions with these test vehicles, are among the subjects of DMV records related to driverless

⁴⁹⁵ 18 U.S.C. §§ 2721–2725 (2012).

⁴⁹⁶ The United States Supreme Court upheld the DPPA against a Tenth Amendment challenge in *Reno v. Condon*, 528 U.S. 141, 120 S. Ct. 666, 145 L. Ed. 2d 587 (2000). The DPPA is an interesting example of federal preemption of state DMV laws that did not offer such privacy protection.

⁴⁹⁷ *Maracich v. Spears*, __ U.S. __, 133 S. Ct. 2191 (2013).

⁴⁹⁸ See *The Drivers Privacy Protection Act (DPPA) and the Privacy of Your State Motor Vehicle Record*, ELECTRONIC PRIVACY INFO. CENTER (2015), <https://epic.org/privacy/drivers/> ("States were required to comply with the minimum requirements of the DPPA by September 1997. Many states are more restrictive than the federal rules.").

⁴⁹⁹ See, e.g., CAL. CODE REGS., tit. 13, §§ 227.00–227.52 (2015) ("Autonomous Vehicles.") Section 227.44 of the Code of Regulations provides for accident reporting requirements.

vehicles.⁴⁹⁹ In the absence of operational regulations that permit the general public to operate driverless vehicles beyond the testing phase, it is difficult to predict either specific DMV driverless vehicle recordkeeping requirements or the privacy protections for personal information associated with driverless vehicles.

b. Fair Information Practices (FIPs) and Personal Information Protection from Privacy Breaches.—Additional state privacy statutes require fair information practices⁵⁰⁰ as part of existing consumer protection laws that will apply to protect the privacy of people who own and use driverless vehicles. Forty-seven states have already enacted privacy breach statutes.⁵⁰¹ These statutes, which are variably called "data breach," "security breach," or "privacy breach" laws, typically protect "personal information," usually defined as a person's name combined with the person's SSN, driver's license or state ID number, account numbers, or other personal information.⁵⁰² Privacy protection extends to improper disclosures of this personal information through unauthorized access, such as hacking, and other types of data losses, including negligence.⁵⁰³ Under a number of these privacy breach statutes, encrypted personal information is exempt from breach notification requirements.⁵⁰⁴ If personal information is improperly disclosed by any covered public- or private-sector entity, each individual whose personal information was disclosed must be notified of the data loss. Such privacy breach notifications have substantial negative consequences—both in terms of monetary and notification costs⁵⁰⁵ and in terms of

⁵⁰⁰ See Robert Gellman, *Fair Information Practices: A Basic History* (Feb. 11, 2015), <http://www.bobgellman.com/rg-docs/rg-FIPShistory.pdf>.

⁵⁰¹ *Security Breach Notification Laws*, NAT'L CONF. OF ST. LEGISLATURES (June 11, 2015), <http://www.ncsl.org/research/telecommunications-and-information-technology/security-breach-notification-laws.aspx> (providing a state-by-state summary, as of June 2015, 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.*

⁵⁰² *Id.*

⁵⁰³ *Id.*

⁵⁰⁴ *Id.* See, e.g., FLA. STAT. § 501.171 (2014); CAL. CIV. CODE § 1789.81.5 (West 2014).

⁵⁰⁵ PONEMON INST., 2014 COST OF DATA BREACH STUDY: UNITED STATES (2014), <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.

harm to business reputation.⁵⁰⁶ Over time, these laws have tended to become increasingly strict. They will apply to driverless vehicle manufacturers, sellers, ride service companies, and indeed, all entities that collect personal information associated with driverless vehicles.

It is not certain whether in the future Congress will enact a national privacy breach statute, or whether state legislatures will specifically adapt their privacy breach laws to information associated with driverless vehicles. If national legislation is enacted to federally regulate driverless vehicles, national privacy protections for personal information related to driverless vehicles would probably be included in that legislation.

2. Communications Privacy Laws

A number of federal communications statutes will protect the privacy of communications to and from driverless vehicles. The specific communications technologies used in a driverless vehicle will determine how communications privacy laws will apply to that particular driverless vehicle.

a. Electronic Communications Privacy Act.—The Electronic Communications Privacy Act (ECPA)⁵⁰⁷ will prohibit unauthorized interception of most electronic communications to and from driverless vehicles. There has been considerable congressional interest in replacing the 3-decades-old ECPA with a communications privacy statute more in sync with 21st-century communications technologies. Although such legislation has not been passed by both houses of Congress, some form of revised electronic communications privacy legislation is likely to be enacted eventually, perhaps by the time driverless vehicles become generally available. To the extent that particular wireless characteristics of driverless vehicle communications appear to require separate legal protection or regulation, it may become necessary to enact a separate regulatory system to protect the privacy of communications associated with these vehicles.

b. Telecommunications Act of 1996—Consumer Proprietary Network Information (CPNI)—Section

⁵⁰⁶ See, e.g., Press Release, Semafore, 86% of Customers Would Shun Brands Following a Data Breach (Mar. 27, 2014), <https://www.semafore.com/86-customers-shun-brands-following-data-breach/>. In a survey of 2000 respondents, 87 percent of customers responded they would avoid brands following a data breach of credit or debit card personal data. *Id.* Where data breaches involved home addresses or telephone numbers, 83 percent of customers replied that they would not likely do business with the privacy-breaching organization again. *Id.*

⁵⁰⁷ Electronic Communications Privacy Act, Pub. L. No. 99-508, 100 Stat. 1848 (1986) (codified as amended at various provisions of Title 18 of the United States Code (2012)).

222 of the Telecommunications Act of 1996 provides privacy protection for what the Act calls “consumer proprietary network information” (CPNI).⁵⁰⁸ The Act defines CPNI as “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,” as well as information contained in conventional telephone bills.⁵⁰⁹ The FCC has been aggressive in enforcing CPNI privacy protections,⁵¹⁰ as they apply to mobile wireless Internet access providers.

In March 2015, the FCC adopted its “Open Internet Order”⁵¹¹ that classifies mobile as well as fixed broadband Internet access service as a telecommunications service regulated under Title II of the Communications Act. Under Title II, CPNI privacy protections apply. How this new Open Internet Order affects wireless communications to and from vehicles is somewhat uncertain, because the FCC apparently intends not to apply the new Open Internet Order to communications services that are not “Basic Internet Access Services.” The FCC Order refers to “limited-purpose devices such as automobile telematics” as an example of the type of non-basic Internet services that the FCC has decided to continue to monitor, rather than regulate as Title II telecommunications services.

There is substantial controversy over consumer privacy aspects of the FCC Open Internet Order as it applies to Internet services. For example, the Federal Trade Commission (FTC) contends that the FTC has primary jurisdiction over Internet privacy matters. Although FCC vehicle communications privacy issues appear to be temporarily in abeyance, it is very likely that there will be enhanced privacy regulation of vehicle communications over the Internet as driverless vehicles become generally available to consumers.

c. Federal Trade Commission Act—The Federal Trade Commission protects consumer privacy and security under its Section 5 authority over “unfair or deceptive acts or practices in or affecting

⁵⁰⁸ 47 U.S.C. § 222 (2012).

⁵⁰⁹ 47 U.S.C. § 222(h)(1)(A) (2012).

⁵¹⁰ For example, in 2014 Verizon agreed to a Consent Decree amounting to \$7,400,000 to settle FCC complaints about misuse of customers’ private information. In the Matter of Verizon, FCC Order File No.: EB-TCD-13-00007027 (Sept. 2, 2014).

⁵¹¹ FED. COMM. COM., “Protecting and Promoting the Open Internet” GN Docket No. 14-28, Report and Order on Remand, Declaratory Ruling, and Order, March 12, 2015.

commerce.”⁵¹² The Commission has been active in both studying and bringing enforcement actions against Internet companies that promise privacy and security of personal information, but fail to provide it.⁵¹³ In January 2015, the Commission issued a staff report in which both connected and driverless vehicles are discussed as examples of the Internet of Things that require privacy protection.⁵¹⁴

In March 2015, the Commission established an Office of Technology Research and Investigation (OTRI) to research technology issues regarding “privacy, data security, *connected cars*, smart homes, algorithmic transparency, emerging payment methods, big data, and the Internet of Things” (emphasis added).⁵¹⁵ The Office will conduct research regarding such devices as connected cars with Mobile Wireless communications that are connected to the Internet. The FTC’s Chief Technologist, Ashkan Soltani, describes a broad array of “investigative research on technology issues involving all facets of the FTC’s consumer protection mission, including privacy, data security, *connected cars*” (emphasis added).⁵¹⁶ In short, the FTC expects to play a major role in consumer privacy aspects of driverless vehicles.

3. Surveillance Privacy

Potential use of a driverless vehicle, or personal data derived from a driverless vehicle, for surveillance of a person (or persons) associated with the vehicle will depend on the electronic systems and technologies contained in the vehicle. Concerns about surveillance focus on tracking an individual’s movements and location either by private-sector entities or by government law enforcement and national security agencies. In matters related to

⁵¹² 15 U.S.C. § 45 (2012).

⁵¹³ FED. TRADE COMM’N, PROTECTING CONSUMER PRIVACY IN AN ERA OF RAPID CHANGE: RECOMMENDATIONS FOR BUSINESSES AND POLICYMAKERS (2012) <https://www.ftc.gov/sites/default/files/documents/reports/federal-trade-commission-report-protecting-consumer-privacy-era-rapid-change-recommendations/120326privacyreport.pdf>. The United States Court of Appeals for the Third Circuit ruled in favor of such an FTC enforcement action in *FTC. v. Wyndham Worldwide Corp.*, No. 14-3414, 2015 U.S. Dist. LEXIS 14839 (3d Cir. Aug. 24, 2015).

⁵¹⁴ FED. TRADE COMM’N, THE INTERNET OF THINGS: PRIVACY AND SECURITY IN A CONNECTED WORLD (2015), <https://www.ftc.gov/system/files/documents/reports/federal-trade-commission-staff-report-november-2013-workshop-entitled-internet-things-privacy/150127iotrpt.pdf>.

⁵¹⁵ Ashkan Soltani, *Booting up a new research office at the FTC*, TECH@FTC BLOG (Mar. 23, 2015), <https://www.ftc.gov/news-events/blogs/techftc/2015/03/booting-new-research-office-ftc>.

⁵¹⁶ *Id.*

personal information security and physical security from stalkers, many of these issues also involve security, Section VII.C, infra.

a. Private-Sector Tracking.—There are at present relatively few laws that apply to private sector tracking and surveillance based on driverless vehicles. However, there have been heated policy discussions about tracking the locations and travels of individuals through ride service companies, such as Uber. Uber has been a particular focus of surveillance privacy concerns.⁵¹⁷ Uber’s controversial 2015 “Privacy Statement”⁵¹⁸ is both shorter than earlier versions and far more transparent about the wide scope of detailed user information collected and shared by Uber. A driverless vehicle version of this type of on-demand ride service would present similar opportunities for surveillance of users.

b. Law Enforcement and National Security Surveillance.—Some laws that protect communications privacy also authorize government interception and electronic surveillance, provided a warrant, or at least an administrative order, is secured. For example, in addition to protections against interception of wireless communications, the Electronic Communications Privacy Act (ECPA) provides for enhanced law enforcement access to communications and records related to driverless vehicles.⁵¹⁹

For example, driverless vehicles that have access to public telephone networks or the Internet will be subject to the Communications Assistance for Law Enforcement Act (CALEA).⁵²⁰ CALEA requires

⁵¹⁷ Controversy over a program, which Uber once called “God’s View” of its users, is instructive. Peter Sims, a technology writer, discovered that his location was secretly being tracked by Uber and asked in a blog post “can we trust Uber?” Peter Sims, *Can We Trust Uber?*, MEDIUM (Sept. 26, 2014), <https://medium.com/@petersimsie/can-we-trust-uber-c0e793deda36>). Eventually, Senator Al Franken sent an inquiry to Uber, which reacted by having a “privacy audit” conducted by a major Washington, D.C., law firm and stating that “God View” of Uber patrons was no longer used. 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>.

⁵¹⁸ *Uber Privacy Statement*, UBER (effective July 15, 2015), <https://www.uber.com/legal/privacy-proposed/users/en>.

⁵¹⁹ With regard to unencrypted DSRC basic safety messages to be transmitted in the clear, the ECPA does not apply at all. 18 U.S.C. § 2510(16) (2012) (providing that such broadcast unencrypted communications—e.g., the DSRC Basic Safety Message—are “readily accessible to the general public” and therefore not protected under the ECPA).

⁵²⁰ See 47 U.S.C. §§ 1001–1010 (2012).

telecommunications carriers to assist law enforcement in gaining access to telecommunications networks.⁵²¹ In 2005, the FCC, which has jurisdiction to prescribe “such rules as are necessary to implement” CALEA requirements,⁵²² extended CALEA’s reach to Voice over Internet Protocol (VoIP) and facilities-based broadband.⁵²³ As a result, driverless vehicles using Wireless Mobility applications will have law enforcement access built into their communications systems.

In contrast, driverless vehicles that communicate only over DSRC V2V closed safety networks appear likely to avoid having to comply with CALEA access by law enforcement. As currently designed, V2V communications take place over ad hoc, private, closed networks that do not interconnect with public telephone systems or the Internet.⁵²⁴ However, if DSRC V2V were expanded to V2I (e.g., with Internet communications to traffic management centers), these communications would probably be interconnected with public Internet or telephone systems. Such communications connected with telephone or Internet networks would be subject to CALEA law enforcement access requirements.⁵²⁵

The Stored Communications Act⁵²⁶ will facilitate law enforcement access to driverless vehicle communications. Such access to stored data related to communications often only requires a subpoena or a “2703(d) order” based on a reasonable belief that the records are relevant and

⁵²¹ 47 U.S.C. § 1002(a)(1) (2012). 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.

⁵²² *Id.* at 14.

⁵²³ See Communications Assistance for Law Enforcement Act and Broadband Access and Services, 20 FCC Rcd. 14989, 14993 (2005).

⁵²⁴ NHTSA READINESS REPORT, *supra* note 216, at xviii.

⁵²⁵ Communications Assistance for Law Enforcement Act and Broadband Access and Services, 20 FCC Rcd. 14989, 14993 (2005). 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) replacement for local telephone service; and 3) the public interest in CALEA’s application. The second factor, known as Substantial Replacement Provision (SRP), has in the past been most important. However, the third factor, public interest in CALEA’s application, might be a basis for applying CALEA.

⁵²⁶ 18 U.S.C. §§ 2701–2712 (2012).

material to a criminal investigation.⁵²⁷ Court decisions have taken varied approaches to permitting law enforcement access to mobile device information held by telecommunications carriers under the Stored Communications Act.⁵²⁸

National security access to driverless vehicle data is governed by the Foreign Intelligence Surveillance Act (FISA)⁵²⁹ and portions of the USA PATRIOT Act. Although the controversial Section 215 of the PATRIOT Act (used as a basis for collecting telephone metadata) has expired, national security surveillance will continue under existing law and executive orders. These surveillance activities would likely find driverless vehicles productive sources of information about a person of interest’s past locations as well as real-time whereabouts.⁵³⁰ A *Wall Street Journal* opinion piece about driverless vehicles concluded with an apt warning: “The privacy revolt that civil libertarians imagine they are seeing over the silly issue of telephone metadata [Section 215] will be nothing when the American people discover how much of their freedom, autonomy and privacy will be sacrificed to enable the wonders of self-driving cars.”⁵³¹

c. *Location Privacy Legislation.*—By the time driverless vehicles become available to consumers, it is likely that privacy legislation designed to protect information about an individual’s location will be enacted. Already, federal legislation⁵³² restricts the Department of Transportation from using fiscal year 2015 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

⁵²⁷ See *id.*, specifically 18 U.S.C. § 2703(d).

⁵²⁸ 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).

⁵²⁹ A Foreign Intelligence Surveillance Act (FISA) order under 50 U.S.C. § 1801 (2012) could authorize interception of connected vehicle communications involving foreign powers or agents of foreign powers.

⁵³⁰ See Stephen Vladeck, *Forget the Patriot Act – Here Are the Privacy Violations You Should Be Worried About*, FOREIGN POLICY (June 1, 2015), <http://foreignpolicy.com/2015/06/01/section-215-patriot-act-expires-surveillance-continues-fisa-court-metadata/> (“America hasn’t even begun to have a meaningful debate about curtailing the government’s right to spy on citizens.”). (Must register to view article.)

⁵³¹ Holman W. Jenkins, Jr., *When Robo-Cars Crash, It’s Your Fault*, WALL ST. J. (June 9, 2015), <http://www.wsj.com/articles/when-robo-cars-crash-its-your-fault-1433891675>.

⁵³² Fiscal Year 2015 Consolidated and Further Continuing Appropriation, Pub. L. No. 113-235, Div. K, § 417, 128 Stat. 2130 (2015).

Procedure Act. This statutory provision prohibits use of federal funds for certain aspects of driverless vehicle development that involve location tracking using GPS signals. Since most experimental driverless vehicles depend on GPS systems, the provision appears to apply to existing driverless automated and connected vehicle funding.

Further location privacy protection legislation is likely at both the federal and state levels. For example, the “Geolocation Privacy and Surveillance Act” (GPS Act), S. 237 (2015) and H.R. 491 (2015), was reintroduced in the 114th Congress by Senator Ron Wyden and Representative Jason Chaffetz. The GPS Act would prohibit businesses from disclosing geographical tracking data. It also provides guidelines for when and how geolocation information can be accessed and used. The proposed legislation requires government agencies to have probable cause warrants to obtain geolocation information. 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.

Because driverless cars will be tempting sources of location information, location privacy legislation specific to driverless vehicles is possible. In any event, additional legislation is likely to be enacted to protect location information about individuals or to restrict collection or disclosure of geolocation information from mobile devices, including vehicles, without the user’s consent.

C. Security Laws

Related to privacy laws discussed above, security laws set standards for data, network hardware, and other security. Cybersecurity is the term often used in regard to securing digital technologies, such as those in driverless vehicles, against external threats. Driverless vehicles will become part of the nation’s critical transportation infrastructure. Currently under development, standards for cybersecurity in this context will need to be in place and reflected in legal requirements.

Driverless vehicles will depend on automated control systems that are particularly vulnerable to sophisticated malware, such as Stuxnet, which was used against Iranian network control software in 2010.⁵³³ Such security threats aimed at automated control systems can jam these control systems,

⁵³³ The Stuxnet virus became infamous in 2010 because of its unprecedented ability to use network controllers to destroy physical infrastructure. See Kim Zetter, *An Unprecedented Look at Stuxnet, The World’s First Digital Weapon*, WIRED (Nov. 3, 2014), <http://www.wired.com/2014/11/count-down-to-zero-day-stuxnet/>.

endangering the vehicle, its contents, and those around it. Driverless vehicle communications (disclosing, for example, the vehicle’s location or intended destination) can be intercepted. Bogus information can be sent to misdirect a driverless vehicle. Both sensors and actuators can be disabled or taken over by remote commands. The notorious hacking of a Jeep Cherokee by security researchers, who remotely took control of vehicle systems, such as steering, illustrates the reality of such threats.⁵³⁴ The unpredictability of future avenues of attacks against driverless vehicle systems makes guarding against such threats difficult to anticipate and to block.

Although legal policy questions about how best to assure the security of driverless vehicles have been asked, there is, as yet, no legislation or regulation requiring specific types or levels of security for driverless vehicles. The absence of such security assurance appears to be among the reasons why the California DMV delayed adoption of operational regulations to permit driverless vehicles to be operated by the public in California.

Of the many unknowns about laws that will apply to driverless vehicles, security laws are among the most obscure. Technical aspects of security for driverless vehicle systems are not at present well understood, despite the fact that they are vitally important. According to a Utah State University researcher, Ryan Gerdes, “[s]ecurity in this [driverless 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.”⁵³⁵ Technical policy questions about how best to provide security for autonomous cars are only just beginning to be asked. Answers, which can be turned into legal rules and standards, will need to be in place before driverless vehicles can safely travel on public roads.

Interrelationships between security and privacy with regard to personal information are reflected in existing regulatory activities by the Federal Trade Commission (FTC) discussed above. The Commission has brought a series of groundbreaking enforcement actions against lax information security as

⁵³⁴ Greenberg, *supra* note 194.

⁵³⁵ 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), <http://www.theatlantic.com/technology/archive/2014/09/when-cars-are-as-hackable-as-cell-phones/379734/>.

“unfair trade practices.” A number of successful enforcement actions have been brought against companies that collected personal information over the Internet but failed to secure it.⁵³⁶ Because driverless cars will be consumer products, they will be subject to FTC scrutiny with regard to the security of personally identifiable information as part of privacy protection.

If NHTSA eventually adopts requirements that all new passenger cars and light trucks have embedded DSRC devices, security requirements for the resulting V2V ad hoc communications networks will be essential. A “Readiness Report” accompanying NHTSA’s 2014 Advance Notice of Proposed Rulemaking, regarding requiring DSRC equipment as a Federal Motor Vehicle Safety Standard, sketched a security management system. The described Public Key Encryption (PKI) security certificate management system⁵³⁷ may not be sufficiently robust. Vehicle security experts disagree about whether NHTSA’s proposed security management system is sufficient. Moreover, the system outlined by NHTSA in its Readiness Report is not proposed for vehicles beyond passenger cars and light trucks. Other vehicles, including heavy trucks and buses, are likely to use DSRC. They also will require strong security requirements for the safe operation of such vehicles, as well as their data exchanges with passenger cars and light trucks.

In addition to communications security, the potential for external control over and manipulation of driverless cars presents distinct security challenges. Experimenters have gained extensive remote access to automated vehicle functions in conventional vehicles.⁵³⁸ Several strategies have been used to seize control over autonomous cars remotely, including 1) providing bogus input information that misdirects the autonomous car to take a particular action or actions; or 2) taking over autonomous car operations through malware or remote control.⁵³⁹

⁵³⁶ See *LabMD, Inc. v. FTC*, 776 F.3d 1275 (11th Cir. 2015); *FTC. v. Wyndham Worldwide Corp.*, No. 14-3414, 2015 U.S. Dist. LEXIS 14839 (3d Cir. Aug. 24, 2015). According to the *National Law Journal*, the FTC had settled 53 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>.

⁵³⁷ NHTSA READINESS REPORT, *supra* note 217.

⁵³⁸ 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>. MILLER & VALASEK, *supra* note 203.

⁵³⁹ SEN. ED MARKEY, *TRACKING & HACKING: SECURITY & PRIVACY GAPS PUT AMERICAN DRIVERS AT RISK* 3 (2015), http://www.markey.senate.gov/imo/media/doc/2015-02-06_MarkeyReport-Tracking_Hacking_CarSecurity%202.pdf.

Technical research is under way regarding these and other driverless vehicle security issues.⁵⁴⁰ However, security standards are not yet in place.⁵⁴¹

In 2014, the Alliance of Automobile Manufacturers and the Association of Global Automakers established a program to collect and share information about existing or potential cyber-related threats and vulnerabilities in motor vehicle electronics or networks. They established a formal Information Sharing and Analysis Center (called an Auto-ISAC). In January 2015, Alliance spokesperson Wade Newton reported, “The industry is in the early stages of establishing a voluntary automobile industry sector information sharing and analysis center—or other comparable program—for collecting and sharing information about existing or potential cyber-related threats.”⁵⁴² Whether this effort will produce significant security breakthroughs remains to be seen.

In the meantime, the National Institute of Standards and Technology (NIST) has considered security issues of this type for some time. For example, guidance useful for security management for driverless vehicles is available in the 2013 comprehensive update to NIST’s *Security and Privacy Controls for Federal Information Systems and Organizations*.⁵⁴³ A 2015 proposed update to NIST’s *Guide to Industrial Control Systems (ICS) Security*⁵⁴⁴ provides tailored guidance regarding specialized security needs in such industries as vehicle manufacturing. Appendix G to the *Guide* interrelates updated Industrial Control System security guidance with the 2013 *Security and Privacy Controls*.⁵⁴⁵ 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 driverless vehicles.

Copyrighted software provides important operation and control systems for advanced vehicles, including driverless vehicles. Security for this software programming is itself protected in part by

⁵⁴⁰ *Id.*

⁵⁴¹ *Id.* at 2.

⁵⁴² Andy Greenberg, *Senate Report Slams Automakers for Leaving Cars Vulnerable to Hackers*, WIRED (Feb. 9, 2015), <http://www.wired.com/2015/02/heres-full-senate-report-shaming-automakers-security/>.

⁵⁴³ NAT’L INST. OF STANDARDS AND TECH., U.S. DEP’T OF COMMERCE, SECURITY AND PRIVACY CONTROLS FOR FEDERAL INFORMATION SYSTEMS AND ORGANIZATIONS (2013), <http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-53r4.pdf>.

⁵⁴⁴ NAT’L INST. OF STANDARDS AND TECH., U.S. DEP’T OF COMMERCE, *Guide to Industrial Control System (ICS) Security* (2015), <http://csrc.nist.gov/publications/Pubs-Drafts.html#SP-800-82-Rev.2>.

⁵⁴⁵ *Id.* at app. G.

what are called anti-circumvention measures that prevent access to and changes in copyrighted vehicle programming. Tampering with anti-circumvention measures is itself a violation of the Digital Millennium Copyright Act (DMCA). Vehicle manufacturers have objected to a proposal by the United States Copyright Office that would exempt “Vehicle software diagnosis, repair, or modification” from copyright liability for tampering.⁵⁴⁶

Vehicle manufacturers claim that vehicle owners only hold licenses to use the software that controls the functioning of their vehicles. In particular, vehicle owners are not authorized by vehicle manufacturers to download or modify software that operates the vehicle. Further, manufacturers claim that programming designed to prevent alteration of copyrighted vehicle software that determines how vehicle electronic control units manage a vehicle’s powertrain and safety systems, as well as infotainment systems, functions as technical anti-circumvention measures. Either downloading (copying) or tampering with this protective programming would violate the DMCA, unless an exemption is approved. The Copyright Office has proposed exemptions from the DMCA’s anti-circumvention provisions for five classes of activities related to vehicle software programming, including activities that involve vehicle software diagnosis, repair, or modification. The Copyright Office has not yet adopted a final rule determining whether vehicle security measures, in the form of copyrighted software, will use copyright protection as an additional means to protect the cybersecurity of vehicles.

VIII. LEGISLATIVE AND REGULATORY ISSUES

Statutes and administrative regulations developed for conventional vehicles will by default apply to driverless vehicles, at least initially. This makes sense, since early driverless vehicles will operate in mixed traffic with conventional as well as automated human-driven vehicles. In the long run, a national driverless vehicle regulatory system, such as that which has developed for aircraft in the United States, is possible. However, at present, regulatory proposals specific to driverless vehicles (aside from licensing measures in a few states) do not exist. A national driverless vehicle law has not yet been proposed.

A 2015 study conducted by the International Transport Forum “could not find evidence of anticipatory

⁵⁴⁶ *Exemption to Prohibition on Circumvention of Copyright Protection Systems for Access Control Technologies*, Notice of Proposed Rulemaking, 79 Fed. Reg. 73856 (Dec. 12, 2014).

regulatory action addressing the potential use cases that could result from large-scale deployment of highly autonomous vehicles.”⁵⁴⁷ Although current laws generally do not discriminate with regard to driverless vehicles,⁵⁴⁸ as discussed in this report, some aspects of existing law will have to change before the general public will be able to use driverless vehicles on United States roads and highways.

A mixture of federal, state, and local laws and regulations will continue to govern driverless vehicles, as they join conventional vehicles on public roads and highways. Eventually, when driverless vehicles become the predominant form of motor vehicle transportation, a number of these laws and regulations are expected gradually to adapt to the unique qualities of driverless vehicles.

A. Federal and State Legal Jurisdiction

The basic structure of legal jurisdiction over driverless vehicles is expected to remain in the existing tiered pattern in which jurisdiction is shared among the federal government, state governments, and local municipalities.⁵⁴⁹ Absent preemption by federal law (for example, by adoption of federal motor vehicle safety standards for driverless vehicles or enactment of a national driverless vehicle law), state law systems will continue to govern most civil and criminal liability issues, as well as vehicle licensing, insurance, land use, and privacy matters. Unless states adopt driverless vehicle laws that override local regulation, local ordinances will govern many aspects of everyday use of driverless vehicles, such as speed limits, parking, ride-services, and the like.

⁵⁴⁷ INTERNATIONAL TRANSPORT FORUM, AUTOMATED AND AUTONOMOUS DRIVING: REGULATION UNDER UNCERTAINTY 9 (2015).

⁵⁴⁸ Act of May 6, 2015, 2015 Tenn. Pub. Acts __, ch. 307 (2015) (H.B. 616) reflects the potential for such discrimination. This state law provides, “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.” *Id.* § 1(a).

⁵⁴⁹ This tiered pattern developed early in the history of the automobile when laws governing automobiles took the form of primarily local, then state laws requiring licensing of vehicles and drivers. At about the same time, early automobile enthusiasts formed automobile clubs often organized as state-based organizations in various states. When proposed federal legislation that would have licensed and standardized vehicles and the qualifications of drivers on a national basis appeared in 1909 (Rep. Cocks, HR 5176, 61st Cong. 1st Sess.) and 1911 (Rep. Wanger, HR 32570, 61st Cong. 3d Sess.), the proposed legislation failed to be enacted, primarily because of objections from the states. See Xenophon Hubby, THE LAW OF AUTOMOBILES (2d. ed. 1909) at 57–83 and 303–17, and Berkeley Reynolds Davids, LAW OF MOTOR VEHICLES (1911).

The multiple layers of federal, state, and local laws that driverless vehicles will encounter include:

- 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 licensing of vehicles and operators, minimum vehicle standards, insurance, roadway usage, and traffic laws, as well as other issues including privacy, security, criminal law, and environmental regulation.
- Local ordinances regarding traffic, pedestrian, and bicycle safety and parking.

Each of these types of legal requirements will operate simultaneously and somewhat independently of each other with regard to driverless vehicles, as is the pattern followed today with regard to conventional motor vehicles.

Federal law could override state and local law by preemption,⁵⁵⁰ but is unlikely to do so initially. Similarly, state law could override local ordinances. An example of state law preempting local legislation regarding driverless vehicles is the recent action by the Tennessee legislature that prohibits localities from excluding use of driverless vehicles within local boundaries.⁵⁵¹

In this tiered legal environment, federal regulation will provide national standards for driverless vehicles, particularly with regard to safety and environmental impacts. Then state laws will build state licensing and registration standards that incorporate federal standards. For example, federal regulations could establish a new driverless vehicles category as a Federal Motor Vehicle Safety Standard (FMVSS).⁵⁵² Then state legislatures and regulatory agencies would adopt compatible state laws and regulations with regard to such matters as licensing driverless vehicles for road use within each state, insurance of driverless vehicles, and the like. Once state law permits driverless vehicles on state roadways, local ordinances will regulate ordinary aspects of how driverless vehicles are used locally, such as parking, speed limits, and the like.

At present, the federal government has not enacted national laws or adopted federal regulations governing

⁵⁵⁰ See U.S. CONST. art. VI, § 2. Preemption is discussed further *supra* at note 297–307 and *infra* at notes 585–591.

⁵⁵¹ Act of May 6, 2015, *supra* note 548.

⁵⁵² NHTSA's separate FMVSS for low speed vehicles, discussed *supra* in the text accompanying notes 247–248, is an example of a special category of motor vehicle safety standards created to respond to a particular form of motor vehicle technology.

driverless vehicles.⁵⁵³ NHTSA is the agency within USDOT most likely to promulgate nationwide regulations that govern driverless vehicles. By statute, NHTSA has jurisdiction over 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."⁵⁵⁴ That would include driverless vehicles. Safety performance standards for motor vehicles and motor vehicle equipment are established by NHTSA as Federal Motor Vehicle Safety Standards.⁵⁵⁵ Driverless vehicles could become a category of vehicles with their own safety standards. In the meantime, they will have to meet federal safety standards in effect at the time the vehicles are built or imported. Under current safety standards, driverless vehicles will have to comply with requirements regarding a wide range of safety features from headlights to bumpers.⁵⁵⁶ These national standards largely explain why the earliest driverless vehicles will look pretty much like conventional vehicles of the same type.

So far, NHTSA has not promulgated safety regulations or standards that specifically regulate driverless vehicles. Instead, in NHTSA's 2013 *Preliminary Statement of Policy Concerning Automated Vehicles*, the agency cautioned: "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."⁵⁵⁷ The agency also

⁵⁵³ NHTSA PRELIMINARY STATEMENT, *supra* note 184, 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.").

⁵⁵⁴ 49 U.S.C. § 30102(a)(6) (2012).

⁵⁵⁵ NHTSA PRELIMINARY STATEMENT, *supra* note 184, 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.").

⁵⁵⁶ As noted above, Google's fleet of driverless cars will take advantage of this 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. DEPT' OF TRANSP., REQUIREMENTS FOR MANUFACTURERS OF LOW SPEED VEHICLES PRODUCED FOR DISTRIBUTION WITHIN THE U.S. MARKET, <http://www.nhtsa.gov/cars/rules/maninfo/lowspeedvehicle.pdf> (outlining requirements for low-speed vehicles).

⁵⁵⁷ NHTSA PRELIMINARY STATEMENT, *supra* note 184, at 14.

noted that “NHTSA does not recommend that states authorize the operation of self-driving vehicles for purposes other than testing at this time.”⁵⁵⁸

B. State Laws

By 2015, four states (California, Florida, Michigan, and Nevada) and the District of Columbia had enacted legislation authorizing testing of driverless vehicles.⁵⁵⁹ Nevada law permits both testing and operation of driverless vehicles on Nevada roads.⁵⁶⁰ In California, 2012 legislation directed the state’s Department of Motor Vehicles (DMV) to adopt regulations for both testing and operation of driverless vehicles in California.⁵⁶¹ The California DMV has adopted regulations that permit testing of driverless vehicles in California,⁵⁶² but was unable to meet a January 1, 2015, statutory deadline for regulations permitting regular public operation of driverless vehicles on California roads.⁵⁶³ Difficulties in determining just how safe driverless vehicles should be required to be in California contributed to the delay in approving regulations that would allow the general public to use driverless vehicles on California roads.⁵⁶⁴

⁵⁵⁸ *Id.*

⁵⁵⁹ AAMVA Autonomous Vehicle Legislation Chart, *supra* note 397. In addition, a chart that shows proposed and enacted state laws related to “automated driving” is posted at Gabriel Weiner & Bryant Walker Smith, *supra* note 397. The legislative situation a year earlier, in 2014, was the same. RAND REPORT, *supra* note 181, at 41.

⁵⁶⁰ NEV. REV. STAT. § 482A.100 (2013); NEV. ADMIN. CODE §§ 482A.200–.290 (2014).

⁵⁶¹ CAL. VEH. CODE § 38750 (West 2014). Insight into California’s regulatory process regarding autonomous vehicles is provided in Bernard C. Soriano, Stephanie L. Dougherty, Brian G. Soublet & Kristin J. Triepke, *Autonomous Vehicles: A Perspective from the California Department of Motor Vehicles, in ROAD VEHICLE AUTOMATION* 15, 15–24 (Geron Meyer & Sven Beiker, eds. 2014).

⁵⁶² CAL. CODE REGS. tit. 13, §§ 227.00–227.52 (2015).

⁵⁶³ CAL. DEPT’ OF MOTOR VEHICLES, INVITATION TO PRE-NOTICE PUBLIC DISCUSSIONS ON PROPOSED REGULATIONS: AUTONOMOUS VEHICLES 1 (2014), 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. DEPT’ OF MOTOR VEHICLES, *supra*.

⁵⁶⁴ CAL. VEH. CODE § 38750; CAL. CODE REGS. tit. 13, §§ 227.04, 227.34, 227.48 (outlining requirements for manufacturer testing only); CAL. DEPT’ OF MOTOR VEHICLES, *supra* note 563, at 1 (calling for a public discussion “to facilitate the development of proposed regulations related to the safe operation of Autonomous Vehicles”).

A number of additional states have considered legislation authorizing testing or operation of driverless vehicles, but the legislation has failed to pass in a far greater number of states than those that have enacted driverless vehicle authorizing legislation.⁵⁶⁵ Virginia has authorized an automated vehicle testing program (Automated Corridors) in limited parts of the state.⁵⁶⁶ In 2014, the Georgia state legislature created a “House Study Committee on Autonomous Vehicle Technology.”⁵⁶⁷ So far, driverless vehicle legislation has not yet been adopted in Georgia.

Other states have simply tolerated experimental driverless vehicles without passing legislation. For example, in Pennsylvania, where Uber has initiated a research program with regard to driverless ride services, state Department of Transportation officials are enthusiastic about driverless vehicle research. Still, “In Pennsylvania, all vehicles must be controlled by a human being... Driverless vehicles are not allowed.”⁵⁶⁸

1. State Roadway Laws and Regulations

Absent special regulations for operating driverless vehicles, once driverless vehicles are allowed on state roadways, they will have to comply with state laws and regulations that have been designed for vehicles with human drivers. Each state owns and controls the rights of way for highways (including interstate highways) and roadways within that state.⁵⁶⁹ That ownership interest makes the states’

⁵⁶⁵ See Weiner & Smith, *supra* note 397.

⁵⁶⁶ Press Release, Governor McAuliffe Announces New Partnership to Make Virginia a Leader in Automated-Vehicle Industry (June 2, 2015), <https://governor.virginia.gov/newsroom/newsarticle?articleId=8526>.

⁵⁶⁷ State of Georgia House Resolution 1265, available at <http://www.legis.ga.gov/Legislation/20132014/143821.pdf>. The Committee’s task was to “Review the implementation of autonomous vehicle technology and determine how this technology could promote research and development in the field of technology in Georgia, identify and examine any complications or liabilities which could arise by allowing such technology, and study the measures necessary in order for the state to implement autonomous vehicle technology on Georgia roads.” *Id.*

⁵⁶⁸ Scott Kraus, *Coopersburg company pioneering driverless truck*, THE MORNING CALL (Allentown, PA) (June 15, 2015), <http://www.mcall.com/news/nationworld/mc-self-driving-truck-coopersburg-20150614-story.html> (quoting Pennsylvania Transportation Department spokesman Rich Kirkpatrick).

⁵⁶⁹ See Transportation FAQs, AM. ROAD & TRANSP. BUILDERS ASS’N (2015), <http://www.artba.org/about/transportation-faqs/#1> (“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, U.S. DEPT’ OF TRANSP., FED. HIGHWAY ADMIN. (May 14, 2015), <http://www.fhwa.dot.gov/interstate/faq.cfm#question5> (“The States own and operate the Interstate highways.”). There are also local municipally owned roads; but the main roads and highways are owned by the states.

concerns about regulating the use of this state property particularly strong.

Initially, driverless vehicles will only be a very small proportion of the users of state roads.⁵⁷⁰ Traffic laws and regulations will continue to be necessary with regard to all other roadway users—conventional cars, trucks, buses, motorcycles, etc. A different set of traffic laws for the initially small cohort of driverless vehicles would result in confusion and unpredictability.

When driverless vehicles appear in greater numbers, they will still need to be able to comply with state roadway laws and regulations adopted for other, mostly human-controlled, road users. Indeed, accurately reading road signs and responding to signals is an essential feature of driverless vehicles currently under development.⁵⁷¹

Ultimately, vehicle regulations will adapt to the special qualities of driverless vehicles. For example, stop signs and stop lights at intersections may become not as useful to driverless vehicles as automated signals (beacons) added to the infrastructure to better communicate with driverless vehicles.

The evolution of driverless vehicles, both on the technology side and on the regulation side, will pose intriguing legal issues for generations of traffic engineers and driverless vehicle system designers, as well as lawyers. In the very long run, when driverless vehicles have proved to be more safe, reliable, and efficient than conventional motor vehicles, conventional motor vehicles could be banned from regular use on most states' public roads.

2. Local Municipal Laws and Regulations

Although municipal ordinances do not, at present, specifically address driverless vehicles, existing local ordinances regarding parking, speed limits, yielding to pedestrians, and bicycles will apply to driverless vehicles.⁵⁷² Usually adopted under state authority, local laws and ordinances typically regulate vehicle usage, particularly with regard to local roadway safety, pedestrian and bicycle safety, and parking.⁵⁷³ Experience with regulation of electric vehicles at the

⁵⁷⁰ See *supra* note 189 for estimates on market penetration of autonomous vehicles.

⁵⁷¹ Lee Gomes, *Hidden Obstacles for Google's Self-Driving Cars*, MIT TECH. REV. (Aug. 28, 2014), <http://www.technologyreview.com/news/530276/hidden-obstacles-for-googles-self-driving-cars/>.

⁵⁷² Apparently some Tennessee localities were threatening to prevent driverless vehicles from crossing their borders. Act of May 6, 2015, *supra* note 548.

⁵⁷³ See Smith, *Automated Vehicles Are Probably Legal in the United States*, *supra* note 180, at 416 (discussing various types of laws that bear on the legality of autonomous vehicles, including "statutes of [states] and other jurisdictions; regulations and practices of administrative agencies within

local level suggests that, once state laws license driverless vehicles to operate on public roads, local municipal regulation will probably follow.⁵⁷⁴

Some local ordinances may require driverless vehicles to operate only in specific designated parts of a municipality allocated for driverless vehicle use. For example, when driverless vehicles are unfamiliar and unproven, they may be excluded from areas around schools and parks where children are present. Later, after establishing a better safety record than human-driven cars, motor vehicle travel in these areas may instead require only driverless vehicles. As driverless vehicles become more widely used and demonstrate enhanced capacities for safe navigation on narrow streets and in congested urban areas, local ordinances may designate such areas for driverless vehicles only.

Among the innovative local law adaptations to driverless vehicles is likely to be special parking regulations. Because driverless vehicles will be capable of more precise and compressed parking, these vehicles will likely be accommodated in more compact and dense storage. Some municipalities may require driverless vehicles not in active use to store themselves in special facilities, located in remote places away from congested urban areas.⁵⁷⁵ Moreover, scenarios for use of driverless vehicles in fleets providing on-demand ride services would reduce the need for on-street parking in commercial areas.⁵⁷⁶ In the

these jurisdictions; and ordinances and other enactments of municipalities and other local authorities"). See also MICH. COMP. LAWS § 257.606 (2009) (reserving for local authorities the power to regulate parking and operation of vehicles); U.S. DEP'T OF TRANSP., FED. HIGHWAY ADMIN., A RESIDENT'S GUIDE FOR CREATING SAFER COMMUNITIES FOR WALKING AND BIKING 11 (2015), http://safety.fhwa.dot.gov/ped_bike/ped_cmnty/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.").

⁵⁷⁴ See, e.g., WASH. STATE DEP'T OF COMMERCE, ELECTRIC VEHICLE INFRASTRUCTURE: A GUIDE FOR LOCAL GOVERNMENTS IN WASHINGTON STATE 3, 5 (2010), 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), 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).

⁵⁷⁵ RAND REPORT, *supra* note 181, 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").

⁵⁷⁶ See *id.*

more distant future, when a driverless car can be easily and quickly summoned from remote storage off-site when needed, building regulations requiring on-site garage space in residential structures may need to change when driverless cars result in no justification for requiring garage space.⁵⁷⁷

C. Federal Driverless Vehicle Regulation

No one entity within the executive branch of the federal government currently has jurisdiction to regulate all aspects of driverless vehicles, although USDOT has the major responsibilities. For example, insofar as connected vehicle communications are aspects of driverless vehicles, the Federal Communications Commission will have a major role with regard to driverless vehicles that are also connected vehicles. The Federal Trade Commission will be concerned with consumer issues. The Environmental Protection Agency will have jurisdiction over such matters as fuel efficiency testing and environmental matters related to driverless vehicles.

Even within the USDOT, no one office or agency has overall responsibility for all driverless vehicle regulation. A specialized agency with concentrated responsibilities for driverless vehicles could be created within USDOT. However, such a consolidation of regulatory authority over driverless vehicles would require statutory authorization and formal reorganization. At present, Congress shows no interest either in establishing a new agency or in authorizing government or departmental reorganization.

Within USDOT, the lead agency with regard to driverless vehicles is currently NHTSA, which has jurisdiction to promulgate regulations that govern the safety of "motor vehicles."⁵⁷⁸ However, NHTSA has so far declined to set driverless vehicle standards on the grounds that they would be premature.⁵⁷⁹

In addition to NHTSA, the Federal Highway Administration is particularly active with regard to infrastructure aspects of driverless vehicles, especially collision avoidance at intersections and roadway signage.⁵⁸⁰ With regard to heavy trucks and buses that will eventually become driverless, the Federal Motor Carrier Safety Administration (FMCSA) has general

jurisdiction over interstate motor carriers.⁵⁸¹ The Federal Transit Administration (FTA), which provides financial and technical assistance to improve local and regional public transit systems, would be involved in transit applications of driverless vehicles.⁵⁸² Most federal research regarding driverless vehicles is conducted under the auspices of the Office of the Assistant Secretary of Transportation for Research and Technology.⁵⁸³ Within the Office of the Assistant Secretary, the Joint Program Office for Intelligent Transportation Systems has provided important research with regard to connected vehicles.⁵⁸⁴

This mosaic of agencies provides a variety of perspectives on driverless vehicles within USDOT that are useful in considering the wide range of technical and policy issues raised by driverless vehicles. Coordination of all driverless vehicle regulatory matters within a single federal regulatory program has not yet been proposed in Congress.

D. Potential for Federal Preemption of State Laws

Congress could enact national legislation that regulates driverless vehicles on a uniform national basis, to the exclusion of state and local laws. Under

national defense and mobility. The FHWA works to improve highway safety and minimize traffic congestion on these and other key facilities. The FHWA bears the responsibility of ensuring that America's roads and highways remain safe, technologically up-to-date, and environmentally-friendly. Through surface transportation programs, innovative and traditional financing mechanisms, and new types of pavement and operational technology, FHWA increases the efficiency by which people and goods move throughout the Nation. The Administration also works to improve the efficiency of highway and road connections to other modes of transportation. The Federal-aid Highway Program's budget is primarily divided between Federal-aid funding and the Federal Lands Highway Program.

Federal Highway Administration, OFFICE OF THE FED. REGISTER, <https://www.federalregister.gov/agencies/federal-highway-administration> (last visited Sept. 20, 2015).

⁵⁷⁷ See *id.*

⁵⁷⁸ 49 U.S.C. § 30102(a)(6) (2012).

⁵⁷⁹ NHTSA PRELIMINARY STATEMENT, *supra* note 184.

⁵⁸⁰ 49 U.S.C. § 104 (2012). On the *Federal Register* Web site, the varied functions of FHWA are described as follows:

FHWA's mission is to improve mobility on our Nation's highways through national leadership, innovation, and program delivery. The Administration works with Federal, State, and local agencies as well as other stakeholders and partners to preserve and improve the National Highway System, which includes the Interstate System and other roads of importance for

⁵⁸¹ 49 U.S.C. § 13906 (2012); 49 C.F.R. § 387.1 (2013).

⁵⁸² Established by section 1 of Reorganization Plan No. 2

of 1968 (5 U.S.C. app. § 1 (2012)), FTA was formerly the Urban Mass Transportation Administration (UMTA).

⁵⁸³ The Research and Innovative Technology Administration (RITA) conducted this research pursuant to 49 U.S.C. § 112, until January 2014, when these research functions were transferred to the Office of the Assistant Secretary. Greg Winfree, *RITA Becomes Office of Research and Technology*, U.S. DEP'T OF TRANSP. (Jan. 30, 2014), <http://www.dot.gov/fastlane/rita-becomes-office-research-and-technology>.

⁵⁸⁴ Within the USDOT Office of the Assistant Secretary for Research and Technology, the ITS Joint Program Office (JPO) carries out responsibilities under Subtitle C- Intelligent Transportation System Research of Public Law 109-59 Safe Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005).

the Supremacy Clause of the United States Constitution, such federal driverless vehicle legislation could preempt varied state laws that will otherwise apply to driverless vehicles.⁵⁸⁵ For example, if a divergence of state laws regulating driverless vehicles in conflicting ways appears to stifle development of driverless vehicles, enactment of such a uniform national law might be considered. However, no such legislation has been introduced in Congress. Within the Executive Branch, near term prospects for uniform national driverless vehicle regulation are extremely unlikely.⁵⁸⁶

Current preemption law, particularly with regard to ground transportation matters, is by no means predictable. Over the past 15 years, the United States Supreme Court has unevenly decided pre-emption issues in the context of vehicle regulation. Two United States Supreme Court decisions—one regarding air bags⁵⁸⁷ and another regarding seatbelts⁵⁸⁸—appear to suggest that, absent an express statutory provision that explicitly preempts state law, federal law might not sufficiently “occupy the field” of driverless car standards and requirements so as to eliminate all state law, particularly state tort law.⁵⁸⁹ The two Supreme Court cases wrestled with state laws regarding tort liability, an area of law that traditionally has been considered especially appropriate for state law.⁵⁹⁰ Moreover, standards for roadways owned by states are usually considered particularly appropriate matters of state, rather than national concern.⁵⁹¹

E. Regulatory Policy

Potential regulation of driverless vehicles presents two basic uncertainties. Driverless vehicle technologies remain under development with no decisions made even about such basic matters as whether connected vehicle technologies should be required equipment in driverless vehicle technologies.

⁵⁸⁵ See U.S. CONST. art. VI, cl. 2.

⁵⁸⁶ See NHTSA PRELIMINARY STATEMENT, *supra* note 184, at 2 (NHTSA does not plan to adopt federal regulation of driverless vehicles in the near future).

⁵⁸⁷ Geier v. American Honda Motor Co., 529 U.S. 861, 120 S. Ct. 1913, 146 L. Ed. 2d 914 (2000) (involving air bags 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).

⁵⁸⁸ Williamson v. Mazda Motor of Am., Inc., 562 U.S. 323, 131 S. Ct. 1131, 179 L. Ed. 2d 75 (2011) (involving seat belts and unanimously finding no federal preemption).

⁵⁸⁹ See also RAND REPORT, *supra* note 181, 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.”).

⁵⁹⁰ Geier, 529 U.S. at 861–68.

⁵⁹¹ *Id.*

In addition, legislative and regulatory jurisdiction over motor vehicles is diffused in the United States between the states and the federal government. At such a time of technical and political uncertainty, a certain degree of regulatory flexibility seems appropriate so as to avoid setting legislative or regulatory requirements too rigidly or too soon, before best practices and designs may have emerged. At this early stage in the development of driverless vehicles, there appears to be regulatory wisdom in leaving options and opportunities for further development and innovation open.

IX. SUSTAINABILITY: LAND USE, ENVIRONMENTAL, AND INFRASTRUCTURE ISSUES

Widespread deployment of driverless vehicles will affect the sustainability of land, environmental resources, and transportation infrastructure. The laws that currently apply to these matters will apply to driverless vehicles, and driverless vehicle development will need to be mindful of sustainability values.

Sustainability involves controlling impacts of transportation and land development on the environment—from traffic on local roads to global climate change. Its objectives are to create less waste; to avoid consuming resource areas (such as wetlands, forests, and agricultural lands); to use less energy; and to emit lower levels of greenhouse gases and other environmental pollutants.⁵⁹² Reflecting the conviction that human living patterns can be shaped so that they do not overwhelm land and resources, sustainable development is committed to creating healthier and more resilient places at local, walkable levels for people to live, work, and play without the need for motor vehicles, which exacerbate regional and global environmental problems.⁵⁹³ Whether driverless vehicles ultimately will contribute to the long-term sustainability of environmental resources and transportation infrastructure will depend, in part, on how laws regarding these matters react to driverless vehicles.

A. Land Use

Driverless vehicles could have profound impacts on land development and create lasting changes in land use patterns.⁵⁹⁴ Land use laws and transportation planning that seek to foster sustainable communities

⁵⁹² About Smart Growth, U.S. ENVT'L PROT. AGENCY (Mar. 20, 2015), <http://www2.epa.gov/smartgrowth/about-smart-growth>.

⁵⁹³ *Id.*

⁵⁹⁴ RAND REPORT, *supra* note 181, at 25. There are dozens of definitions of sustainable communities. See also ABOUT US, PARTNERSHIP FOR SUSTAINABLE COMMUNITIES (Mar. 2, 2015), <http://www.sustainablecommunities.gov/mission/about-us>.

will need to take account of driverless vehicles. At present, land and transportation regulators, as well as land use lawyers, are uncertain about whether driverless vehicles will contribute to communities that offer convenient places to live and work, as well as contribute to environmentally sustainable air, land, and water resource usage.⁵⁹⁵

In the United States, the Partnership for Sustainable Communities—a joint project of the Department of Housing and Urban Development, the Department of Transportation, and the Environmental Protection Agency—promotes sustainable land use measures. The objective is “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.”⁵⁹⁶ Providing more transportation choices is among the key livability principles the Partnership promotes.⁵⁹⁷ “Develop[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.”⁵⁹⁸ Driverless vehicles are expected to contribute to all of these goals.

1. Vehicle Miles Traveled

Land use regulatory efforts to decrease reliance on motor vehicles typically apply a concept called “vehicle miles traveled” (VMT) to measure changes in vehicle usage. For example, transportation engineers use VMT in calculating the level-of-service (LOS) of a roadway. VMT is also used in many other contexts as well. USDOT’s Bureau of Transportation Statistics in the Federal Highway Administration currently collects and publishes information about miles traveled in all states by all types of vehicles for the Highway Performance Monitoring System (HPMS).⁵⁹⁹

Records of motor vehicle miles traveled date back

⁵⁹⁵ See, e.g., RAND REPORT, *supra* note 181, at xvi (“The overall effect of AV [driverless vehicle] technology on energy use and pollution is uncertain....”); JANE BIERSTEDT, AARON GOOZE, CHRIS GRAY, JOSH PETERMAN, LEON RAYKIN & JERRY WALTERS, EFFECTS OF NEXT-GENERATION VEHICLES ON TRAVEL DEMAND AND HIGHWAY CAPACITY 11–18 (2014).

⁵⁹⁶ *About Us*, PARTNERSHIP FOR SUSTAINABLE COMMUNITIES, *supra* note 594.

⁵⁹⁷ *Livability Principles*, PARTNERSHIP FOR SUSTAINABLE COMMUNITIES (Oct. 31, 2013), <http://www.sustainablecommunities.gov/mission/livability-principles>.

⁵⁹⁸ *Id.*

⁵⁹⁹ See, e.g., *Highway Statistics 2013*, U.S. DEP’T OF TRANSP., FED. HIGHWAY ADMIN. (Nov. 7, 2014), <http://www.fhwa.dot.gov/policyinformation/statistics.cfm>.

to the early years of automobiles. As early as the 1920s, vehicle miles traveled data were collected by the Department of Commerce as a measure of increased economic activity.⁶⁰⁰ The Federal Highway Administration began collecting VMT statistics from states in 1945.⁶⁰¹ USDOT currently uses this vehicle miles traveled data, primarily from the Highway Performance Monitoring System (HPMS),⁶⁰² both for determining Corporate Average Fuel Economy (CAFE) fuel efficiency standards⁶⁰³ and for measuring road usage for federal highway funding purposes.⁶⁰⁴ In addition, EPA also relies on vehicle miles traveled as a basis for regulating mobile air pollution sources, particularly vehicle tailpipe emissions.⁶⁰⁵

According to the EPA’s 2001 report *Our Built and Natural Environments*, “[C]hanges in development patterns [i.e., sprawl] have had a particularly significant impact on VMT growth. Furthermore, because additional road capacity can be absorbed quickly by induced traffic, adding capacity alone is not likely to solve the problem of rapidly rising VMT.”⁶⁰⁶ In the 21st century, transportation and land planning seek to minimize vehicle miles traveled for environmental and fuel economy reasons. In addition, sprawl development is viewed as both aesthetically unappealing and wasteful of land resources.

VMT measurements are already an integral part of federal transportation planning. They are the most likely basis for charging highway usage fees in road-use-charging proposals designed to increase or to supplement revenues for highway maintenance and

⁶⁰⁰ See, e.g., BUREAU OF THE CENSUS, U.S. DEP’T OF COMMERCE, HISTORICAL STATISTICS OF THE UNITED STATES 1789–1945, at 223 (1949) (listing miles traveled in the United States each year).

⁶⁰¹ *Highway Statistics Series*, U.S. DEP’T OF TRANSP., FED. HIGHWAY ADMIN. (Nov. 7, 2014), <http://www.fhwa.dot.gov/policyinformation/statistics.cfm>.

⁶⁰² MICHAEL GRANT ET AL., U.S. DEP’T OF TRANSP., FED. HIGHWAY ADMIN., HANDBOOK FOR ESTIMATING TRANSPORTATION GREENHOUSE GASES FOR INTEGRATION INTO THE PLANNING PROCESS 65–66 (2013), http://www.fhwa.dot.gov/environment/climate_change/mitigation/publications_and_tools/ghg-handbook/.

⁶⁰³ See, e.g., *id.* at 81–82 (discussing using vehicle miles traveled in conjunction with CAFE standards).

⁶⁰⁴ See FHWA Strategic Plan, U.S. DEP’T OF TRANSP., FED. HIGHWAY ADMIN. (Mar. 24, 2015), <https://www.fhwa.dot.gov/policy/fhplan.cfm> (describing measurement of “demand and use of transportation facilities” in vehicle miles traveled).

⁶⁰⁵ See Ellen Kinee & Allan Beidler, *Revised Methodology for the Spatial Allocation of VMT and Mobile Source Emissions Data*, <http://www.epa.gov/ttnchie1/conference/ei10/modeling/stella.pdf>.

⁶⁰⁶ U.S. ENVT'L PROT. AGENCY, OUR BUILT AND NATURAL ENVIRONMENTS 25 (1st ed. 2001), <http://www2.epa.gov/smart-growth/our-built-and-natural-environments-technical-review-interactions-between-land-use>.

construction.⁶⁰⁷ Declines in gasoline taxes, in part because of electric cars, as well as declines in vehicle usage associated with higher gasoline prices, point toward the need to replace the Highway Trust Fund's reliance on gasoline taxes for revenue.⁶⁰⁸ In generating funds for roadway systems, fees based on the number of vehicle miles traveled on these roadways seem to be an attractive potential revenue alternative.⁶⁰⁹

Because charging for road use requires calculating the vehicle miles traveled by a specific vehicle within a state, pilot studies have used onboard devices, often based on GPS, to capture distances the vehicle has been driven within the state.⁶¹⁰ In driverless vehicles, the miles traveled by a vehicle within a geographical area could be routinely collected. If the driverless vehicle has V2I connected vehicle technologies, this miles-traveled information could be automatically transmitted to road-fee collectors who would be able to charge the driverless vehicle for particular use of specific roads.

Vehicle miles traveled is also used as a way to measure sustainability. California's Sustainable Communities Act⁶¹¹ provides an example of state sustainability regulation that seeks to foster sustainable communities through reductions in vehicle miles traveled.⁶¹² This Act requires regional land use planning and regulation to reduce use of passenger cars and light trucks through measurable decreases in vehicle miles traveled. This complex land use regulatory system provides an example of how VMT measurements can, for regulatory purposes, count the miles traveled only by particular types of vehicles. Adapting such a system to treat miles traveled by driverless vehicles as

⁶⁰⁷ See, e.g., *Road Pricing Defined*, U.S. DEPT OF TRANSP., FED. HIGHWAY ADMIN., http://www.fhwa.dot.gov/ipd/revenue/road_pricing/defined/vmt.aspx (last visited Sept. 20, 2015) (discussing charging VMT fees for roadway use).

⁶⁰⁸ See Kevin DeGood & Michael Madowitz, *Switching from a Gas Tax to a Mileage-Based User Fee*, CENT. FOR AM. PROGRESS (Jul. 11, 2014), <https://www.americanprogress.org/issues/tax-reform/report/2014/07/11/93657/switching-from-a-gas-tax-to-a-mileage-based-user-fee/>.

⁶⁰⁹ *Road Pricing Defined*, *supra* note 607. USDOT has studied such road use charging for many years and conducted pilot programs in Oregon and Iowa.

⁶¹⁰ *Id.* But see DeGood & Madowitz, *supra* note 608.

⁶¹¹ Sustainable Communities and Climate Protection Act of 2008, 2008 Cal. Stat. 5065.

⁶¹² CAL. GOV'T CODE § 14522.1(b)(1)-(2) (West Supp. 2014) (requiring the use of vehicle miles traveled by passenger cars and light trucks as a factor in determining guidelines for the development of regional transportation plans). Regarding the VMT concept used in the California Sustainable Communities regulations, VMT does not mean total vehicle miles traveled by all vehicles as may be used in calculation of roadway levels of service or in road-use charging systems. Rather it counts only miles traveled by passenger cars and light trucks.

a separate category could be used to incentivize or disincentivize driverless vehicle use.

2. Uncertain Impact of Driverless Vehicles on Vehicle Miles Traveled

There has been considerable debate and research regarding whether driverless vehicles will be used to travel more or fewer vehicle miles. The 2014 RAND Report concluded equivocally that “[t]he potential effects of AVs [driverless vehicles] on aggregate vehicle miles traveled remain unclear, though it seems likely they will lead to more total travel rather than less.”⁶¹³

Some land planners believe that the convenience of driverless vehicles for commuting between home and work may lead to more scattered residential development in rural areas, away from urban centers.⁶¹⁴ In a driverless vehicle, the ability to use commuting time for other purposes, such as work, rest, or recreation, may make commute time and distance less onerous for driverless vehicle users. If so, driverless vehicle users may be encouraged to live in rural or semi-rural areas and to use a driverless vehicle to commute to work, school, or shopping. In short, many land planners are concerned that the convenience benefits of driverless vehicles will result in longer commutes.⁶¹⁵

On the other hand, to the extent that driverless vehicles are deployed as low-speed vehicles permitted only in urban areas, driverless vehicles could incentivize more dense residential land development patterns. It may be that the availability of driverless vehicles, including on-demand ride-sharing versions,⁶¹⁶ will be an amenity available only in urban areas.⁶¹⁷ Such an enhanced personal mobility option may encourage residents to choose to live in more dense urban areas.

Indeed, economical use of driverless vehicles for providing convenient and inexpensive⁶¹⁸ on-demand

⁶¹³ RAND REPORT, *supra* note 181, at 17.

⁶¹⁴ *Id.* at 18.

⁶¹⁵ E.g., David Levinson, *Climbing Mount Next: The Effects of Autonomous Vehicles on Society*, 16 MINN. J. SCI. & TECH. 787, 807 (2015).

⁶¹⁶ California regulates these ride-service companies as Transportation Network Companies (TNCs). A number of other states have followed California's regulatory lead.

⁶¹⁷ RAND REPORT, *supra* note 181, at 26.

⁶¹⁸ A 2013 study by Columbia University's Earth Institute showed that roughly 9,000 autonomous cars would be able to replace all of the taxi cabs in New York City and provide wait time of just over half a minute and fares of about 50 cents per mile. Lawrence D. Burns, William C. Jordan & Bonnie A. Scarbourough, *Transforming Personal Mobility* 24 (2013), <http://sustainablemobility.ei.columbia.edu/files/2012/12/Transforming-Personal-Mobility-Jan-27-2013.pdf>. See also John Markoff, *Google's Next Phase in Driverless Cars*, 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>.

transportation (online ride-services or taxi applications) requires fairly high population densities.⁶¹⁹ Moreover, detailed dynamic roadway mapping may, at least initially, only be available in urbanized areas. Land or transportation planning regulations could also restrict driverless vehicles to urban areas. A state law or local ordinance could also permit the use of driverless vehicles only in designated parts of urban areas, or parts of a municipality.

Driverless vehicles in the form of low speed vehicles will generally be useful only for relatively short-distance intra-urban journeys from residence to work, recreation, shopping, or public transit hubs providing transport for longer distance journeys.⁶²⁰ Low-speed driverless vehicles operating over shorter distances in urban areas would lead to fewer long-distance miles traveled by this type of driverless vehicle and perhaps greater use of public transportation for journeys over longer distances.

Restricting driverless vehicles to already dense urban areas, either by practical factors (such as the availability of dynamic digital mapping) or by legal regulation, could have the advantage of making dense urban communities more maneuverable, particularly for elderly and disabled persons for whom personal mobility is often difficult.⁶²¹ Moreover, particularly in older cities, chronically congested areas could be zoned for driverless vehicles only.⁶²² In areas characterized by narrow streets and difficult-to-navigate pavement, driverless vehicles might be the safest, as well as the most rational, form of ground transportation.

Whether the total number of miles traveled by driverless vehicles is likely to increase or decrease overall VMT presents another issue. A study by the University of Michigan Transportation Research Institute considered the “Potential Impact of Self-Driving Vehicles on Household Vehicle Demand and Usage.”⁶²³ The

⁶¹⁹ RAND REPORT, *supra* note 181, at 27.

⁶²⁰ *Id.* at 18.

⁶²¹ *Id.* at 16–17; Loro, *supra* note 245. A study at Carnegie Mellon University estimated the increase in vehicle usage when driverless cars enabled use by disabled and elderly persons. Chris Hendrickson, Allen Biehler & Yeganeh Mashayekn, CONNECTED AND AUTONOMOUS VEHICLES 2040 VISION FINAL REPORT (2014) (hereinafter PENNSYLVANIA REPORT), <http://www.ssti.us/wp/wp-content/uploads/2014/11/Connected-Autonomous-Vehicles-2040-Vision-Final-Report-Task-10.pdf>.

⁶²² 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).

⁶²³ BRANDON SCHOETTLE & MICHAEL SIVAK, UNIV. OF MICH. TRANSP. RESEARCH INST., POTENTIAL IMPACT OF SELF-DRIVING VEHICLES ON HOUSEHOLD DEMAND AND USAGE (2015), <http://www.driverlesstransportation.com/wp-content/uploads/2015/02/UMTRI-2015-3.pdf>.

results of this study indicate that driverless vehicles would likely lead to fewer cars being owned by the average household.⁶²⁴ 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.⁶²⁵ The research also suggests that such a driverless vehicle usage pattern would probably result in cars wearing out sooner, with more frequent purchases of new cars.⁶²⁶ If newer driverless vehicles have better, cleaner technology, a frequent replacement pattern could contribute to long-term sustainability and environmental benefits.⁶²⁷

B. Environment

Driverless vehicles are expected to further sustainable community goals of reducing air pollution and greenhouse gas emissions, such as carbon dioxide.⁶²⁸ Although driverless vehicles could be powered by internal combustion engines, it is also possible that driverless vehicle technologies could, by regulation, only be available in zero-emission vehicles. It is unclear whether such a regulation would incentivize purchase of driverless vehicles or, on the other hand, discourage their purchase.

No matter what their fuel or energy source is, driverless vehicles are expected to contribute to environmental improvement by reducing air pollution through avoiding traffic congestion and the accidents that generate traffic snarls.⁶²⁹ Intelligent routing will enable driverless vehicles to reduce fuel consumption and emissions.⁶³⁰ Moreover, by eliminating many car crashes, driverless vehicles are expected to reduce air pollution from traffic backups due to vehicle crashes that would otherwise be generated by conventional vehicle crashes.⁶³¹ In the long run, as driverless vehicles prove effective in avoiding crashes, it should be possible to reduce vehicle weight, which adds to fuel consumption and

⁶²⁴ *Id.* at 12.

⁶²⁵ *Id.*

⁶²⁶ *Id.* at 10.

⁶²⁷ 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/>.

⁶²⁸ *Id.*; Jonathan Walker & Karen Crofton, *Autonomous Vehicles & Smart Cities Can Cut Auto Fatalities & CO₂ Emissions by 2025*, CLEANTECHNICA (Nov. 14, 2014), <http://cleantechica.com/2014/11/14/autonomous-vehicles-smart-cities-can-cut-auto-fatalities-co2-emissions-2025/>.

⁶²⁹ Walker & Crofton, *supra* note 628.

⁶³⁰ RAND REPORT, *supra* note 181, at 18 (“[T]o the extent that AVs are able to promote smoother traffic patterns, they should lead to improved fuel economy and, in turn, lower fuel costs.”).

⁶³¹ RAND REPORT, *supra* note 181, at 22–23; Walker & Crofton, *supra* note 628.

emissions.⁶³² For example, robust passive safety equipment such as heavy bumpers or rollover protection systems may no longer be necessary for occupant safety in driverless vehicles that do not crash or drive off roadways.

C. Infrastructure Requirements

Most transportation experts expect that driverless vehicles will initially have minimal impact on infrastructure requirements, since driverless vehicles will initially operate in mixed traffic on existing roadways shared with conventional, human-driven vehicles.⁶³³

As noted earlier in this report, it is uncertain whether driverless vehicles will add to or reduce overall vehicle roadway use. One report suggests that there will be a measure of additional roadway demand from elderly persons, persons with disabilities, and those ineligible to drive because of age.⁶³⁴ Such increases in travel demand appear likely to be offset by increases in both lane capacity and roadway capacity because driverless vehicles are capable of making more efficient use of existing roadways.

Over the next decade or so, conventional vehicles, with which driverless vehicles will interact, are likely to change in a couple of important ways. First, many human-driven vehicles are likely to become increasingly automated and will utilize many of the same types of automated vehicle systems as driverless vehicles.⁶³⁵ Second, connected vehicle technologies may enable pervasive cooperative vehicle interaction among both driverless and conventional vehicles, at least in new passenger vehicles and light trucks. This change will come about if NHTSA carries out the agency's announced plans to require DSRC connected vehicle V2V capabilities as safety equipment on all new passenger cars and light trucks.⁶³⁶

Eventually it may make sense to designate portions of roadways (dedicated lanes) or entirely segregated roads for use only by driverless vehicles, because driverless vehicles operate safely in narrower lanes

⁶³² 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.").

⁶³³ GARRISON & LEVINSON, *supra* note 249, at 457.

⁶³⁴ PENNSYLVANIA REPORT, *supra* note 621, at 14. The report calculates potential increases in travel demand on roadways in Pennsylvania and concludes that there are so many uncertainties that projecting increases in travel demand caused by new vehicle users is difficult to calculate. *Id.* at 15.

⁶³⁵ NHTSA PRELIMINARY STATEMENT, *supra* note 184, at 1.

⁶³⁶ NHTSA READINESS REPORT, *supra* note 216, at 5, 71. This FMVSS will apply only to a segment of even driverless vehicles on the road, because the proposal does not include trucks, buses, and other heavy vehicles.

and with reduced vehicle headways.⁶³⁷ Adding separated or dedicated roadways for use only by driverless vehicles is likely to be resisted because such lanes would involve the cost both of adding infrastructure and of additional land for rights-of-way.

Alternatively, it would be possible to designate existing roadway or highway lanes for driverless vehicle use only. Driverless vehicle lanes might be marked as "star" lanes, to distinguish them from existing diamond lanes that now accommodate carpools, electric vehicles, and those paying tolls to use High Occupancy Toll (HOT) lanes. A "star" lane for driverless vehicles could be narrower and move faster. It would also have greater throughput than ordinary roadways or travel lanes on highways. The result would be more efficient use of rights-of-way and existing infrastructure. A 2014 Report for the Pennsylvania Department of Transportation estimates that driverless vehicles would increase lane capacity by roughly 40 percent during peak travel times.⁶³⁸

Providing such segregated driverless vehicle lanes might be a way to incentivize the purchase of driverless vehicles, just as access to carpool lanes has incentivized purchases of electric vehicles. Despite its many benefits, such a proposal would, however, almost certainly generate significant political opposition from other roadway users. Such a reaction greeted restricted use of carpool lanes and, particularly, the eligibility of electric vehicles for free use of carpool or High Occupancy Toll (HOT) lanes.⁶³⁹

Conventional traffic signs and signals will need to remain during the time both driverless and conventional vehicles are sharing roadways. Even at a time when all vehicles are driverless, traffic signs and traffic lights will probably be needed for use by bicyclists and pedestrians.⁶⁴⁰ Infrastructure improvement to enhance performance of driverless vehicles may, however, require retrofitting existing signage with special beacons to communicate direct data inputs to driverless vehicles.⁶⁴¹

⁶³⁷ PENNSYLVANIA REPORT, *supra* note 621, at 12. The report provides a table considering 13 factors related to driverless vehicles that are likely to impact roadway capacity and flow. *Id.*

⁶³⁸ *Id.* at 13.

⁶³⁹ 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.").

⁶⁴⁰ PENNSYLVANIA REPORT, *supra* note 621, at 16.

⁶⁴¹ *Id.* at 30. The report notes that signal controllers and other ITS systems may need to be upgraded to communicate with driverless vehicles. According to the report, "Traffic signals are perhaps one of the most costly and challenging elements" of driverless vehicle deployment with regard to infrastructure. *Id.*

To the extent that driverless vehicle operation will depend on connected vehicle V2I communications, additional communications infrastructure will likely be required. For example, infrastructure will be required to download security certificates for the DSRC V2V system contemplated in NHTSA's Connected Vehicles Readiness Study.⁶⁴² If V2I becomes part of the DSRC program, additional infrastructure in the form of antennas, roadside processing, and communications units will be necessary.⁶⁴³ It has not yet been determined whether driverless vehicles will rely on V2V ad hoc communications, or whether V2I communications will become aspects of a new vehicle communications infrastructure for driverless vehicles.

In the absence of connected vehicle technologies, or alongside them, sensor reflectors or beacons added to existing signage infrastructure are likely to enhance some driverless vehicle operations.⁶⁴⁴ If so, aside from strictly V2V communications, additional electronic equipment such as controllers may need to be added to transportation infrastructure, probably along existing rights-of-way.⁶⁴⁵ Indeed a variety of infrastructure upgrades may enhance autonomous vehicle reliability, security, and safety. These infrastructure improvements would, of course, also exacerbate land use and environmental impacts of roadway infrastructure.

Infrastructure improvements compatible with driverless vehicles will need to be installed depending on the technologies used by future driverless vehicles. Existing electronic infrastructure is likely to require significant and costly improvements to facilitate the use, effectiveness, and safety of emerging driverless vehicle technologies.

X. CONCLUSION

Driverless vehicles will bring many advantages over conventional vehicles. Enhanced safety, mobility, convenience, and environmental benefits are among these improvements. At the same time, driverless vehicles also will present challenges to the legal system. Although the current legal environment could probably accommodate driverless vehicles with relatively few alterations, changes in the legal system will be required with regard to such matters as insurance and regulatory requirements.

As described in this report, an elaborate framework of legal rules has gradually grown up around transportation innovations, especially motor vehicles. Existing legal rules regulate how motor

vehicles are designed, manufactured, sold, repaired, and used. Laws also establish how liability should be imposed for injuries caused by motor vehicles; the sorts of misconduct that will be punished as criminal; as well as the nature of insurable risks with regard to driverless vehicles. The legal system also establishes appropriate uses of land for roads, highways, and other transportation infrastructure as well as how that infrastructure will be financed. This existing, historically determined, legal architecture will remain for a time. But the legal system will gradually adapt to how driverless vehicles operate.

Driverless vehicle technologies appear to be transforming much more rapidly than the legal system, which tends to evolve slowly, to apply past precedents, and to modify those precedents only cautiously. The legal response to driverless vehicles has already begun with basic measures, such as laws that simply authorize the use of these vehicles in some states. More complex and far-reaching legal changes will evolve over time. As driverless vehicles grow more sophisticated and common, they will assuredly generate many novel issues of law. Initially, the legal rules devised for driverless vehicles likely will be shaped by analogies to conventional vehicles. Over time, however, policymakers will come to better appreciate, and begin to focus on, the unique capacities of, and challenges presented by, driverless vehicles and the system that supports them.

There is also a substantial likelihood that driverless vehicles will produce some far-reaching changes in the law. Just as railroads provided the catalyst for new legal doctrines in the 19th century, the advent of driverless vehicles may produce substantial changes in the prevailing legal culture in the 21st century. Legal rules governing the artificial intelligence that operates driverless vehicles is an example of a novel area of law that will develop with regard to driverless vehicles. Once established within the law pertaining to driverless vehicles, these new rules may be extended to other settings and technology applications, until the rules become generally accepted legal principles.

Overall, however, forecasts regarding the "likely" or optimal legal policy responses to driverless vehicles should be made only tentatively, and with deep appreciation of their inherent limits. About the only certainty associated with the legal environment for driverless vehicles is that these devices will challenge the ingenuity of federal, state, and local policymakers alike as they merge onto the nation's roads.

⁶⁴² NHTSA READINESS REPORT, *supra* note 216.

⁶⁴³ *Id.* at 41–42.

⁶⁴⁴ *Id.*

⁶⁴⁵ *Id.*

ACRONYMS

AAMVA—American Association of Motor Vehicle Administrators	ISO—International Organization for Standardization
ABS—Anti-Lock Braking System	JPO—Joint Program Office for Intelligent Transportation Systems
ACA—The Patient Protection and Affordable Care Act	LOS—Level-of-Service
ANPRM—Advance Notice of Proposed Rulemaking	LTE—Long Term Evolution (a standard for wireless communication of high-speed data)
AV—Autonomous Vehicle	NAIC—National Association of Insurance Commissioners
BIAS—Broadband Internet Access Service	NFIP—National Flood Insurance Program
BSM—Basic Safety Message	NHTSA—National Highway Traffic Safety Administration
CAFE—Corporate Average Fuel Economy	OEM—Original Equipment Manufacturer
CALEA—Communications Assistance for Law Enforcement Act	SARTRE—Safe Road Trains for the Environment
CAN bus—Control Areas Network Connector	SAE—Society of Automotive Engineers
CPNI—Consumer Proprietary Network Information	TNC—Transportation Network Company (online Ride Service Companies such as Uber, Lyft, etc.)
CPUC—California Public Utilities Commission	UM/UIM—Uninsured/Underinsured Motorist Coverage
DARPA—Defense Advanced Research Projects Agency	UMTA—Urban Mass Transportation Administration
DMCA—Digital Millennium Copyright Act	USDOT—United States Department of Transportation
DPPA—Federal Driver Privacy Protection Act	V2V, V2I—Vehicle to Vehicle and Vehicle to Infrastructure Communication
DSRC—Dedicated Short Range Communications	VII—Vehicle Infrastructure Integration
DMV—Department of Motor Vehicles	VMT—Vehicle Miles Traveled
DUI—Driving Under the Influence	
ECPA—Electronic Communications Privacy Act	
ERISA—Employee Retirement Income Security Act	
ESC—Electronic Stability Control	
FAA—Federal Aviation Administration	
FCC—Federal Communications Commission	
FHWA—Federal Highway Administration	
FIO—Federal Insurance Office	
FMVSS—Federal Motor Vehicle Safety Standards	
FR—Financial Responsibility Laws	
FTC—Federal Trade Commission	
GPS—Global Positioning Satellite System	
HMI—Human-Machine Interface	
HPMS—Highway Performance Monitoring System	

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