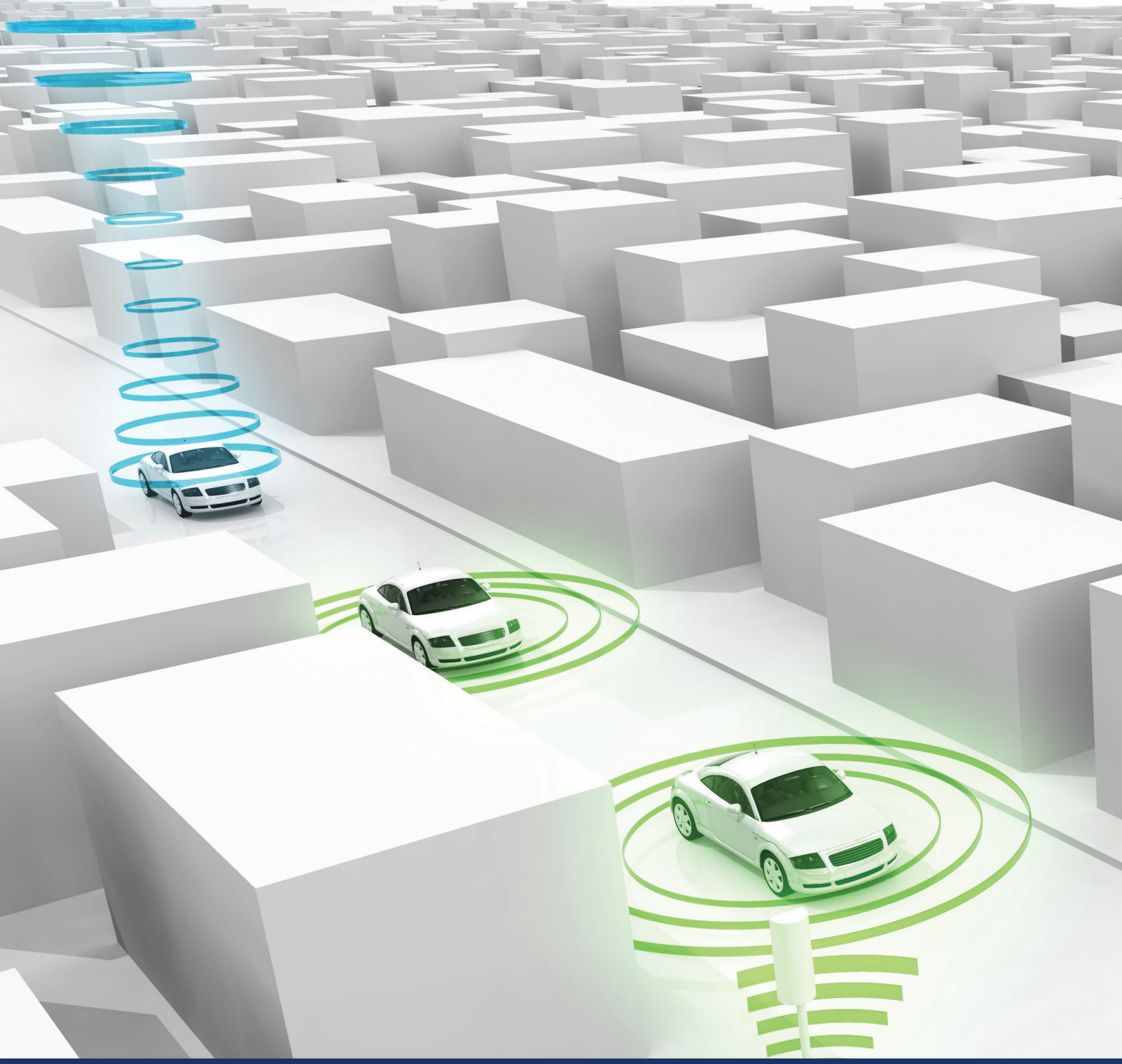

INSURANCE AND THE EVOLUTION OF AUTOMATED DRIVING SYSTEMS

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Introduction

Most late-model cars on the road today have automated features and crash-avoidance technology, including blind-spot monitoring, forward-collision warnings, and lane-departure warnings. Active safety functions like pedestrian detection and adaptive cruise control are increasingly likely to become standard features on even moderately priced cars. Tesla leads the headlines, but other car manufacturers have promised to have fully automated cars available by the end of the decade. Morgan Stanley's auto analysts believe these technologies "should become practically standard equipment by the 2019 model year" and that cars without those features will become "increasingly difficult to sell" and insure.

This white paper explores the important questions that need to be addressed as automation in cars continues to evolve. The first section defines the levels of development of autonomy, examines how automated driving systems (ADS) can be integrated into the existing driver-operated environment, and considers how ADS may be adopted on a larger scale into the shared economy. The second section outlines the existing private passenger auto insurance market, how ADS will impact that market, and how private passenger auto insurance can address the introduction and adoption of ADS.

Automated Driving Systems: Technology

To understand automated driving systems (ADS), it is important to set common metrics on what is and is not autonomy. "The Preliminary Statement of Policy Concerning Automated Vehicles" by the National Highway Transportation Safety Administration (NHTSA) has adopted the SAE International (SAE) definitions for levels of automation. The SAE definitions divide vehicles into levels based on "who does what, when." Generally:

- At SAE Level 0, the human driver does everything;
- At SAE Level 1, an automated system on the vehicle can sometimes assist the human driver conduct some parts of the driving task;
- At SAE Level 2, an automated system on the vehicle can conduct some parts of the driving task, while the human continues to monitor the driving environment and performs the rest of the driving task;
- At SAE Level 3, an automated system can actually conduct some parts of the driving task and monitor the driving environment in some instances, but the human driver must be ready to take back control when the automated system requests;
- At SAE Level 4, an automated system can conduct the driving task and monitor the driving environment, and the human need not take back control, but the automated system can operate only in certain environments and under certain conditions; and
- At SAE Level 5, the automated system can perform all driving tasks, under all conditions that a human driver could perform them.

There are hundreds of plans to develop ADS and a limited number of research vehicles operating on public roads, but there are no Level 4 and 5 ADS offered for sale to private owners. Whether and when ADS will be permitted to operate on the roads will depend greatly on proven technological developments, regulatory definitions and permission, and – perhaps most of all – public demand and acceptance that driverless cars have the requisite level of safety.

Dozens of established carmakers, technology companies, and startups are conducting internal tests to develop ADS. Tesla is perhaps the best known, with its announcement that all vehicles currently in production have full self-driving hardware installed. Google has been testing for more than six years, accumulating more than 1 million miles of autonomous driving. Toyota has a five-year, $1 billion budget to pursue artificial intelligence and robotics technology. Apple reportedly may team with BMW on Apple's i3-based Project Titan.

In 2015, Audi's "piloted driving" A7 drove from Silicon Valley, California, to Las Vegas, Nevada, with minimal driver input, experiencing both open-road and city-traffic situations. Porsche's InnoDrive onboard navigation system may be introduced in Europe by Audi. Nissan has the Intelligent Driving System concept, combining artificial intelligence and electric propulsion, and Renault-Nissan claims 10,000 employees are working toward autonomous-driving commercialization, but not all carmakers are testing their own vehicles. Public records sourced from the California Department of Motor Vehicles show the Ford Fusion and the Lexus RX450h make up more than 80 percent of self-driving cars that are not being tested by their own manufacturers.

Automated Driving Systems: Integration

As automated driving systems (ADS) enter the market, they will operate alongside driver-operated vehicles. There are more than 250 million cars and trucks on U.S. roads today, with almost all at around Level 2 automation at best. The average age of these vehicles is 11.6 years, meaning that tens of millions of driver-operated vehicles will be driving on the road for quite a while. Even if Level 4 cars were technically proven and regulatorily approved today, it would take years for users to accept and buy enough of these ADS to change the balance of predominately driver-operated cars and trucks.

Full or even majority automated integration is by no means certain. Enhanced technology will mean autonomous cars will be more expensive to buy and maintain. There will be substantial sections of the U.S. population that simply may not be able to afford that autonomy, or choose not to. Urban areas may make the most practical sense for autonomous car development, but millions of rural drivers may not be availed of the same benefits. There are also millions of drivers who simply enjoy driving and operating their own car and have little inclination to ride along in a shared pod on a computer-selected route at pre-established speeds.

It should also be factored in that many existing auto owners may *never* develop the requisite trust and comfort required for automated cars. A Volvo survey found that only 43 percent of people would be comfortable in an autonomous car without a steering wheel. People may have actual physical issues with autonomous cars, with the University of Michigan estimating that 6 percent to 12 percent of American adults riding in fully self-driving vehicles will experience moderate or severe motion sickness at some time.

No one can say for sure how long it will take for wide public acceptance of autonomous cars. "Driver" cars took approximately 80 years from the date of first commercial availability to reach 90 percent adoption and air travel took approximately 60 years. More recently, mobile phones took 30 years and smartphones have taken only 10 years. Actual adoption will depend on several factors: regulatory challenges, cost to the consumer, safety, vehicle ownership preferences, technology, and possibly other new factors that have not yet been identified.

Automated Driving Systems: Usage

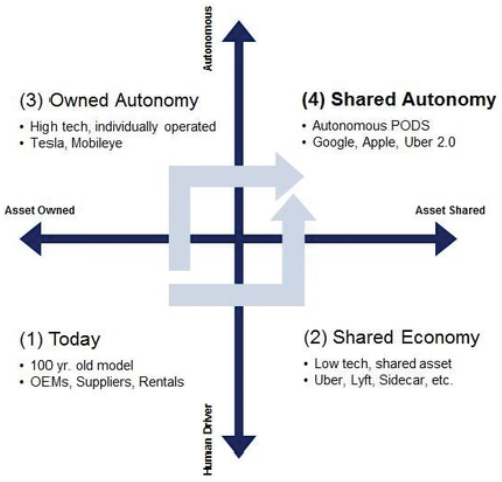
The evolution of autonomous cars is not just how smart and capable the cars may become or how many are available but an equal – if not greater – issue is how these cars will be owned and operated. Like the levels of automated driving systems (ADS), vehicle usage can be divided into categories, based on the role of the vehicle and the role of the owner/operator:

- Ownership/Lease – The consumer owns the autonomous car. They are individually responsible for all the maintenance, insurance, and upkeep. Property loss and liability issues may fall to the owner.

- Shared Ownership – A group of consumers collectively own the autonomous car. They share responsibility for all the maintenance, insurance, and upkeep. This could be a family, a small group, or a larger collective group. Participants determine how to allocate any shared property loss and liability.

- Service-based – This is most like a taxi or transportation network company. Users pay for access by the ride or for a defined time period. The user has use but limited control over or responsibility for the car, which is owned by someone else, stored elsewhere, and maintained elsewhere. Maintenance and upkeep of the car is the responsibility of the owner, not the user. Property loss and liability issues are with the owner.

Shared usage could have a profound impact on how Americans drive and own cars. A study by the University of Texas at Austin of how the advent of autonomous cars may change vehicle ownership found that each shared autonomous vehicle may replace about 11 conventional vehicles. If that is correct, the 250 million vehicles now on the road in the U.S. could shrink to 22.7 million.



Ride sharing and other service companies are working with major automakers. One possible paradigm shift is a move from an automotive-product-based ownership model to a use-based service model. For instance, Ford has committed to building an autonomous vehicle specifically aimed at ride-sharing. GM spent $1 billion on a software startup called Cruise Automation, invested $500 million in Uber rival Lyft, and installed a GM

executive on the ride-sharing company's board. And Mercedes-Benz Vans envisions a move from ownership to usage.

Morgan Stanley analyst Adam Jonas says the auto industry is being eyed by outside players that want in on the $10 trillion mobility market and that the future of the industry is going to revolve around two major developments: autonomous driving and the shared economy. Jonas breaks it down into four quadrants: the status quo of today; the shared mobility market with the likes of Uber; "owned autonomy," in which drivers are giving up control of cars to a computer; and "shared autonomy," in which fleets of completely ADS are operating 24 hours a day.

Clearly, this is going to get complicated.

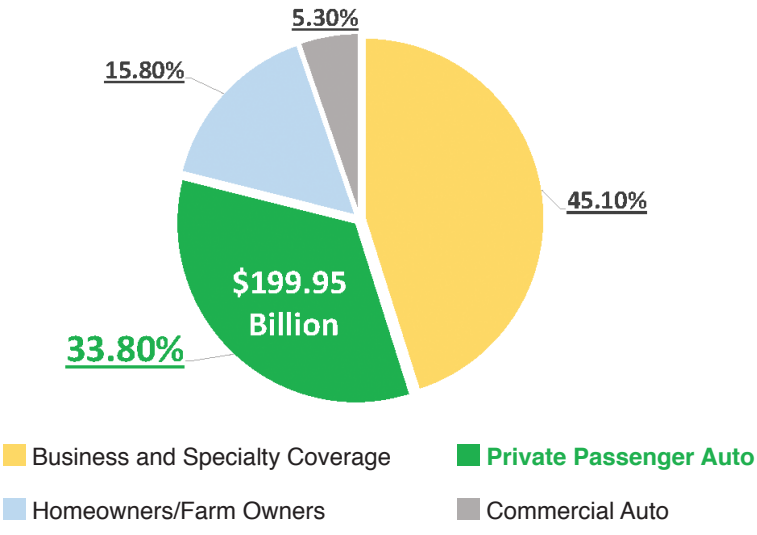
What Will Automated Driving Systems Mean to the Auto Insurance Industry?

There is no question that the ongoing developments of autonomy in cars will have a significant impact on the business of private-passenger auto insurance. According to the Insurance Information Institute, private-passenger auto insurance is by far the largest line of insurance. The chart below outlines the total premiums paid for property/casualty insurance in 2015.

According to the National Highway Transportation Safety Administration (NHTSA), 94 percent of auto crashes are a result of driver error, and automated cars should reduce the rate and severity of automobile crashes. Far fewer deaths and less severe injuries are predicted with the advent of automated cars. Although automated cars – and damage thereto – will be more expensive, some predict the reduced frequency of crashes could reduce overall damages. The shared economy of autonomous cars could result in fewer cars that will be shared among users. This also means that many – if not most – of the shared users will not be owners. The users will depend on the owners to insure for vehicle damage and operational liability. This confluence of factors could result in less vehicles owned by even fewer owners who experience a decrease in the frequency and severity of accidents, which means a decline in private-passenger auto insurance policies and premium dollars.

According to the 2016 Aon report "Global Insurance Market Opportunities," U.S. personal auto insurance premiums could decline by about 20 percent from their 2015 levels with general adoption of autonomous cars and could fall by more than 40 percent by the time ADS reach full adoption.

As cars become more automated, the need for liability coverage will not disappear, but liability could shift; perhaps with manufacturers and suppliers assuming greater responsibility. The RAND



Corporation's "2014 Guide for Policymakers" concluded that product liability might incorporate the concept of cost-benefit analysis to mitigate the cost to manufacturers of claims. Coverage for physical damage due to a crash and for losses not caused by crashes – wind, floods, theft – may change less. If the potentially higher costs to repair or replace damaged vehicles are more than offset by the lower accident frequency rate, some coverage may become cheaper.

Underwriting

To understand how automated driving systems (ADS) may impact the private-passenger auto insurance market, perhaps the first factor to consider is underwriting. Many of the traditional driver-operated underwriting criteria, such as the number and kinds of crashes an applicant has had, the miles he or she expects to drive, and where the car is garaged, will still apply. With autonomous cars, the make, model, and style of car will assume much more underwriting importance. It will be critical to monitor developing hardware and software enhancements/updates and how they are or are not integrated into the vehicle to understand evolving risk levels.

Another underwriting factor that will become more important will be where the autonomous vehicle is kept and driven. Different geographic areas may build infrastructure that facilitates autonomous driving, such as dedicated lanes, while other areas may have natural or man-made conditions that could act as an impediment to automated driving.

Since the car will be doing the "driving" for the purposes of underwriting and claims related to autonomous cars, private-passenger auto insurers may have to rely heavily on telematic devices in the car to record and report locations and user activity. The National Association of Insurance Commissioners forecasts that the use of telematics may grow to up to 20 percent within the next five years. This results, however, in privacy concerns. There are indications that insurance policies that depend on data about the user's behavior submitted by an electronic device have attracted a smaller than expected percentage of the driving population, possibly because people do not want to be monitored. How insurers collect, maintain, and use that data is a critical operational decision and is subject to cyber and hacking issues.

Perhaps even more complicated is the ongoing development of less than fully autonomous cars and how to appreciate and underwrite auto insurance policies that consider the various risks. One concern is that current generations of ADS, like the autopilot feature offered by Tesla Motors, may be lulling some drivers into a false sense of security that can contribute to distracted driving and crashes. Increased – but not full – automation may result in a driver assuming that the car can or will do more than it is designed to do. With that false sense of security, drivers may actually focus less on the driving skills that are not yet automated.

Just as they have done with other automotive advances, from seatbelts to lane-departure warnings, private-passenger auto insurance companies will identify, collect, and analyze data over time and adjust policy coverage and premiums to reflect the impact of developments as needed. Autonomous car technology, usage, and business models will be disruptive for the insurance industry, as software is continuously updated, usage trends change, and better analytics are defined. As concrete information on the potential risk exposures faced by the different waves of autonomous

cars is collected and reviewed, underwriting policies will adapt, policies will be revisited, and pricing will be revised. There may need to be an entirely new skill set for underwriters that is more akin to an IT professional.

Regulation

Transportation regulators will set requirements for automated vehicle performance and operation. Insurance regulators include these regulations and myriad other factors into their reviews and approvals of automated vehicle insurance policies. This will clearly be a whole new area for these regulators. In a Munich Re survey conducted at the 2016 Risk and Insurance Management Society Conference, close to half of the risk managers (41 percent) cited regulatory or legislative obstacles as posing the greatest challenge to the widespread adoption of automated driving systems (ADS).

Private-passenger auto insurance is state-regulated and every indication is that this will generally continue to be the case. There are concerns that state regulations could inhibit interstate use of ADS, but the National Highway Transportation Safety Administration (NHTSA) "Preliminary Statement of Policy Concerning Automated Vehicles" and other federal indications to date are that states will retain their authority in this area.

Each jurisdiction has its own set of rules and regulations for auto insurance and, to the extent they have done so, for autonomous cars. The Insurance Information Institute defines current state auto liability insurance laws as falling into four broad categories: no-fault, choice no-fault, tort liability, and add-on.

- No-fault: Each insurance company compensates its own policyholders for the cost of minor injuries, regardless of who was at fault in the crash.
- Choice no-fault: Drivers may select one of two options: a no-fault auto insurance policy or a traditional tort liability policy.
- Tort liability: The party at fault in a car crash can be sued by injured parties.
- Add-on: Drivers receive compensation from their own insurance company as they do in no-fault states, but there are no restrictions on lawsuits.

It is not clear whether and how these auto insurance regimes may change with the introduction and integration of ADS. There could be a model state law, as proposed by the NHTSA or perhaps the federal government may decide to step into a greater role. With decision-making and "driving" shifting from the driver to the car, auto manufacturers will likely be required to accept more responsibility for damage and injuries, and the manufacturers will perhaps seek a single federal government standard rather than complying with the rules of state – and even local – jurisdictions. Insurers will be better able to adapt to the new world of autonomous cars when a clearer regulatory framework emerges.

Liability

Apart from a Level 5 fully automated car – and one in which the user has no options for control – the driver of a less than fully automated car will retain the potential for liability for any incident. Until such perfected vehicles are permitted to operate on public roads and the sole responsibility for car crashes shifts to auto makers, suppliers, and service providers, prudence and state regulations will probably dictate that drivers and owners maintain the same property/casualty auto insurance responsibilities that they have today.

Liability issues will vary greatly with varying levels of automation, and there is no present certainty around criminal and civil liability for crashes. How liability will pass among the driver, the manufacturer, parts suppliers, and software companies in varying levels of autonomy will be dealt with on a case-by-case basis in the courts. In a perfect world, there would be some sort of universal framework for determining liability to provide clarity both to the industry and consumers, but this will depend on the development of the embryonic technology, regulations, and business cases that eventually emerge.

The more driver error is eliminated from the equation, the more an auto insurance market will be based not on driver responsibility, but rather on vehicle safety system performance and manufacturer and supplier product liability. Some manufacturers and industry leaders have suggested that they will clear the path to operations and regulation by being the responsible parties. Mercedes, Google, and Volvo have reportedly agreed they will accept full liability for their vehicles in autonomous mode but exactly what the eventual contract language will entail is uncertain. Other companies, suppliers, and service providers developing autonomous car business plans have not yet weighed in, even generally.

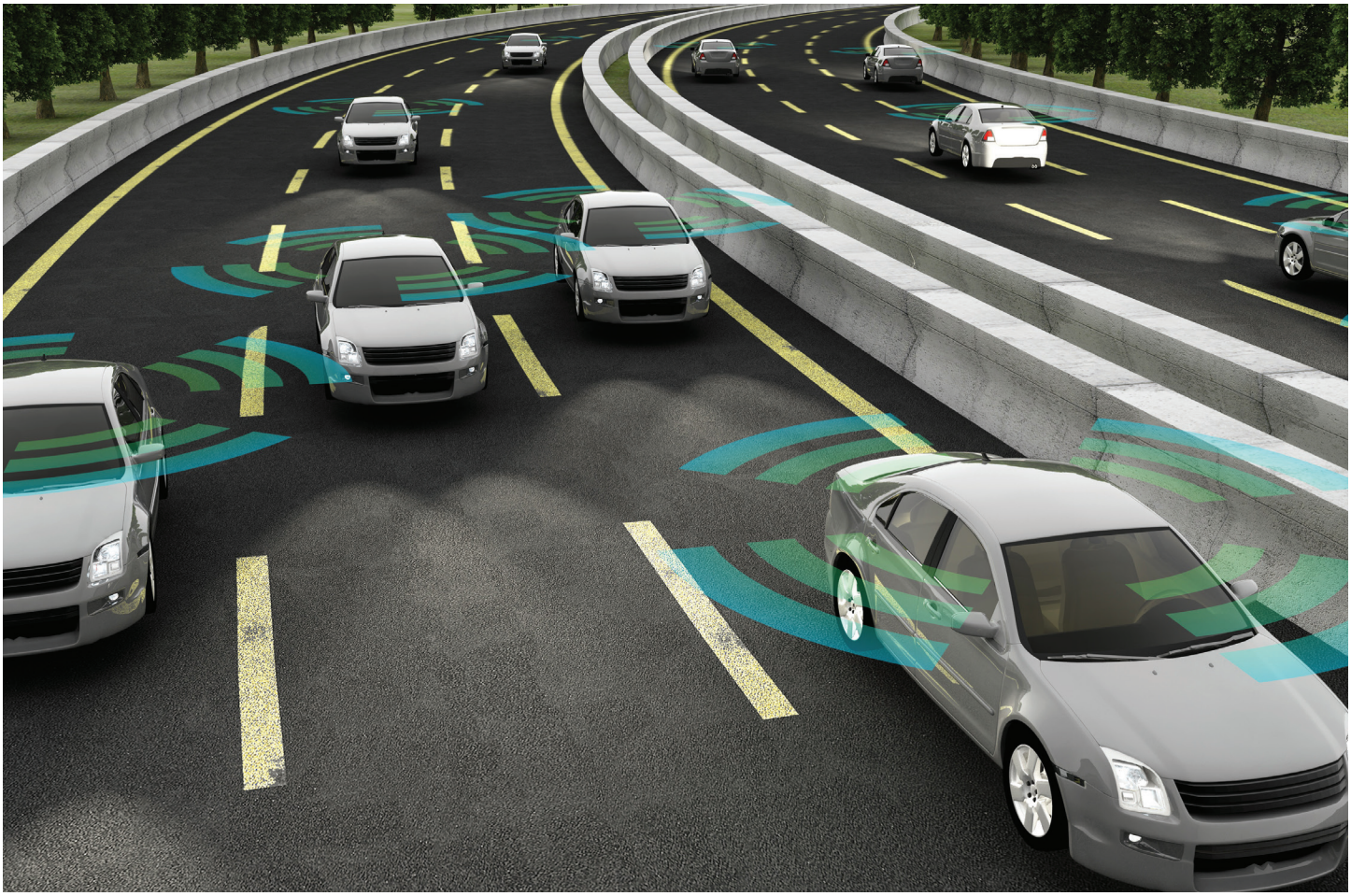
As benevolent as these broad statements appear to be, it is not unlikely that the actual legal commitments will contain a plethora of waivers, conditions, carve outs, exceptions, limitations, and liability caps. Even the most generous and open liability commitments must be structured in a way to ensure that litigation will not drive manufacturers and their suppliers out of business.

Conclusion

Although the road ahead is unclear, insurers must serve their role to develop sound risk management practices for automated and highly automated vehicles. The seductive promises of passive users transported in complete safety ignore the hard truth that even with perfect software and hardware, crashes will happen as a matter of physics and are likely while traditional and highly automated vehicles share the road for decades. The future development, ownership, and operation of autonomous cars are too dynamic to preclude the likelihood of errors, unanticipated crashes and incidents, and other insurable events.

Insurance protection for operators, passengers, and other people will be a critical component regardless of how and when automated vehicles develop. In this rapidly evolving development, the insurance industry's decades of expertise in safety analysis, risk management, mitigation, and coverage will be paramount. Critical technical, legal, regulatory, legislative, policy, and other questions will need to include consideration of how to provide the operators, passengers, and others with the financial and personal security that insurance provides.

NAMIC will continue working at every stage with federal, state, and local governments, auto manufacturers, and other policymakers to ensure that laws, regulations, and policies guarantee those safeguards.



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Tom has recently served on NHTSA panels relating to state jurisdiction and pre-market approval. He is as a Board Member of Advocates for Highway Safety and Auto Safety, and is working with the Insurance Institute for Highway Safety supporting the Virginia Tech Transportation Institute as part of the National Cooperative Highway Research Program.

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