U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON ENERGY AND COMMERCE

March 24, 2017

TO: Members, Subcommittee on Digital Commerce and Consumer Protection

FROM: Committee Majority Staff

RE: Hearing entitled "Self-Driving Cars: Levels of Automation"

I. INTRODUCTION

On Tuesday, March 28, 2017, at 10:00 a.m. in 2322 Rayburn House Office Building, the Subcommittee on Digital Commerce and Consumer Protection will hold a hearing entitled "Self-Driving Cars: Levels of Automation."

II. WITNESSES

- Jeff Klei, President, North America Automotive Divisions, Continental AG;
- Kay Stepper, Ph.D., Vice President for Automated Driving and Driver Assistance Systems, Robert Bosch LLC;
- Bill Gouse, Director of Federal Programs, SAE International; and
- David Zuby, Executive Vice President and Chief Research Officer, Insurance Institute for Highway Safety.

III. BACKGROUND

A. Overview

Advanced driver assistance systems (ADAS) are modern automotive safety technologies that monitor and provide warnings about surrounding roadway activity, and supply additional braking and steering support to a driver throughout a driving trip.[1] They are crash avoidance systems intended to minimize the impact of blind spots, alert drivers when they stray from a designated lane, and detect and react to a variety of roadway obstacles in order to prevent a crash or reduce the severity of a collision.[2] Newer ADAS technologies entering the market today extend beyond information, warning, and driver assistance functions and are capable of semi-autonomous driving. For example, "highway autopilot with lane changing" enables a vehicle to drive autonomously on highways and change lanes on its own.[3] "Autonomous valet parking" enables

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1 See http://www.mckinsey.com/industries/semiconductors/our-insights/advanced-driver-assistance-systems-challenges-and-opportunities-ahead
2 See https://www.cartelligent.com/blog/should-your-next-car-have-crash-prevention-system
3 See https://www.bcgperspectives.com/content/articles/automotive-consumer-insight-revolution-drivers-seat-road-autonomous-vehicles/?chapter=2

a vehicle to identify an open parking spot, park itself, and then retrieve itself when summoned.[4] "Traffic jam autopilot" or "traffic jam assist" takes control of a vehicle's functions in low speed, stop and go traffic conditions.[5]

ADAS technologies have been around for more than a decade, but certain systems are gradually becoming a standard feature in many new vehicles.[6] To operate, these systems rely on software, ultrasonic sensors, cameras, lasers, and short- and long-range radar to detect roadway activity, anticipate collisions, and take corrective steering action to avoid a potential hazard.[7] In some cases, these technologies can be retrofitted to older vehicle models.[8] The National Transportation Safety Board conducted a study where it found that 94 percent of traffic fatalities could be eliminated if passenger cars were equipped with a suite of collision avoidance systems.[9]

In addition to these safety benefits, ADAS technologies are considered to be the building blocks of fully self-driving cars.[10] As mentioned above, some of these systems have semi-autonomous capabilities that enable the vehicle to control itself briefly in carefully defined situations.[11] Although the driver must be ready to override automatic control of these systems at all times, the incremental advances in a vehicle's sensing, intelligence, and control capabilities provided by ADAS are paving the way for a future of complete vehicle autonomy.[12]

B. Types of Advanced Driver Assistance Systems

The most common ADAS technologies on the market today include forward collision warning, lane departure warning and prevention, blind spot detection, automatic emergency braking (AEB), and adaptive headlights.[13]

Forward collision warning uses cameras, laser beams, and sometimes radar to scan the road ahead for any potential obstacles.[14] If the warning system detects that the driver is at risk of hitting another vehicle ahead and the driver does not take sufficient action, the system may sound-off an audible alert to the driver, while simultaneously preparing the vehicle's brakes to make a full stop.[15] Some forward collision warning systems may also tighten seat belts in

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4 Id.
5 Id.
6 See http://www.iihs.org/iihs/topics/t/automation-and-crash-avoidance/topicoverview; See also https://www.mema.org/sites/default/files/MEMA%20BCG%20ADAS%20Report.pdf
7 See http://www.consumerreports.org/car-safety/collision-avoidance-systems-are-changing-the-look-of-car-safety/
8 Id. See also http://www.consumerreports.org/cro/news/2014/05/how-to-update-any-car-with-forward-collision-and-lane-departure-warnings/index.htm
9 See http://www.citylab.com/tech/2015/06/2220-reasons-your-next-car-should-brake-for-you/395528/
10 See https://www.mema.org/sites/default/files/MEMA%20BCG%20ADAS%20Report.pdf
11 See http://www.ti.com/lit/wp/sszy019/sszy019.pdf
12 Id.
13 See http://www.iihs.org/iihs/ratings/crash-avoidance-features
14 Id.
15 Id.

preparation for a collision.[16] Field testing shows that rear-end collisions are reduced by about 10 percent in vehicles equipped with forward collision warning systems.[17]

Lane departure warning notifies drivers when their vehicle drifts or moves outside of marked lanes without the driver activating the vehicle's turn signal.[18] With these systems, the driver is responsible for taking any corrective action to align the vehicle within the appropriate lane.[19] Lane departure prevention systems however will "gently steer the car to automatically re-center it in the lane."[20] A recent study found that lane departure warning and prevention systems could help reduce the number of crashes by 26.1 and 32.7 percent respectively.[21]

Blind spot detection systems use ultrasonic sensors to monitor lanes to the driver's left and right in order to fill visibility gaps left by the vehicle's mirrors.[22] When a car enters the driver's blind spot, the system will alert the driver to its presence typically by a light that is activated on either the driver or passenger-side mirror.[23] If the driver proceeds to turn or engages the turn signal while another vehicle is still in the driver's blind spot, the blind spot detection system may send a more urgent signal to the driver – through either a steering wheel vibration or louder alert – indicating that it is not safe to make a lane change.[24]

Automatic emergency braking works by automatically applying a vehicle's brakes without input from the driver if the system detects an imminent rear-end collision.[25] The system can also provide additional braking support to the driver's own braking effort to assist in avoiding a crash.[26] It is estimated that automatic emergency braking systems can help reduce crashes by 14 to 15 percent.[27]

Adaptive headlights are lights that turn or rotate as the driver steers to "better illuminate bends in the road."[28] Adaptive headlights are capable of lighting up more of the road's surface and help improve the driver's sight distance at night.[29] Some adaptive headlights are also able to adjust in response to weather conditions, the presence of other vehicles, or varying light conditions on the road.[30] One study found that adaptive headlights resulted in a ten percent

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16 See http://www.consumerreports.org/cro/magazine/2014/04/the-road-to-self-driving-cars/index.htm; or https://www.cartelligent.com/blog/should-your-next-car-have-crash-prevention-system
17 See https://www.aaafoundation.org/forward-collision-warning-systems
18 See https://mycardoeswhat.org/safety-features/lane-departure-warning/
19 See https://www.aaafoundation.org/lane-departure-warning-system
20 Id.
21 See https://www-esv.nhtsa.dot.gov/Proceedings/24/files/24ESV-000080.PDF
22 See http://www.autotrader.com/car-news/are-blind-spot-monitors-worth-the-extra-money-225249; See also http://www.proctorcars.com/how-do-blind-spot-monitors-work/
23 Id.
24 Id.
25 See http://www.usatoday.com/story/money/cars/2016/03/17/automatic-emergency-braking-coming-all-cars-2022/81907516/
26 See https://www.safercar.gov/Vehicle-Shoppers/Safety-Technology/AEB/aeb
27 See http://www.consumerreports.org/cro/magazine/2014/04/the-road-to-self-driving-cars/index.htm
28 See http://www.autobytel.com/car-buying-guides/features/10-cars-with-adaptive-headlights-131125/
29 See https://www.lifewire.com/what-are-adaptive-headlights-534820
30 Id.

decrease in insurance claims and helped improve a driver's reaction times by about a third of a second.[31]

C. SAE Automation Levels

To establish consistency within the growing market of ADAS technologies, SAE International, a standards-setting organization, developed a system that categorizes driving assistance and automation technologies into six levels.[32]

Level 0, "No Automation," defines vehicles that require a human driver to perform all aspects of the driving task, even if enhanced by a warning or intervention system.[33] Level 1, "Driver Assistance," refers to vehicles that are equipped with a driver assistance system that can perform a single task, either the steering or acceleration/deceleration driving function.[34] The human driver however is expected to perform all other aspects of the driving task.[35] Level 2, "Partial Automation," defines a vehicle that has one or more driver assistance systems that can perform both the steering and acceleration/deceleration driving functions.[36] In Level 2 vehicles, the human driver is also expected to perform all remaining aspects of the driving task.[37] All semi-autonomous systems on the road today are considered to be Level 2 automated driving systems.[38]

Level 3, "Conditional Automation," refers to vehicles that are capable of performing all aspects of the driving task without the input of a human driver.[39] This includes making decisions about changing lanes and passing other vehicles.[40] A human driver must be prepared to respond to a request to intervene by the vehicle at any time, however the driver is not expected to constantly monitor the driving environment.[41] A Level 3 vehicle may request the human driver to intervene in poor weather situations or when lane markings are not present.[42]

Level 4, "High Automation," refers to vehicles capable of performing all aspects of the driving task without human input and can handle almost any roadway situation by itself.[43] Level 4 vehicles will most likely have geographic limitations, but will not expect the human driver to

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31 Id. See also http://www.consumerreports.org/car-safety/collision-avoidance-systems-are-changing-the-look-of-car-safety/
32 See https://www.sae.org/news/3544/
33 Id.
34 Id. See also https://www.wired.com/2016/08/self-driving-car-levels-sae-nhtsa/
35 Id.
36 Id.
37 Id.
38 See http://mashable.com/2016/08/26/autonomous-car-timeline-and-tech/#EC3fU_1HjEqp
39 See https://www.sae.org/news/3544/; See also https://www.wired.com/2016/08/self-driving-car-levels-sae-nhtsa/
40 Id.
41 Id.
42 Id.
43 Id.

intervene.[44] Level 5, "Full Automation," defines vehicles where the automated driving system can perform all aspects of the driving task under all roadway and environmental conditions.[45]

The most notable difference between Levels 0 through 2 and Levels 3 through 5 is that a human driver must always monitor the driving environment in Levels 0 through 2, whereas the automated driving system is capable of monitoring the driving environment in Levels 3 through 5.[46]

D. NHTSA

Federal Automated Vehicles Policy

Last September, the National Highway Traffic Safety Administration (NHTSA) released a Federal Automated Vehicles Policy (FAVP) to establish a foundation and framework for the safe introduction and deployment of highly autonomous vehicles.[47] In the FAVP, NHTSA adopts SAE International's levels of automation for its own use to help bring standardization to the various levels of automation on the market and under development.[48]

New Car Assessment Program

The New Car Assessment Program (NCAP) was established in 1978 to evaluate the safety performance of passenger cars in frontal impact tests.[49] The NCAP also includes the 5-Star Safety Ratings program to "provide comparative information on the safety of new vehicles to assist consumers with vehicle purchasing decisions and encourage motor vehicle manufacturers to make vehicle safety improvements."[50] In December 2015, NHTSA issued a Request for Comment seeking public input on the agency's plans to update the NCAP.[51] In updating the NCAP, NHTSA announced plans to add safety ratings for ADAS or crash avoidance technologies, such as forward collision warning and lane departure warning, and develop a new approach for determining a vehicle's overall 5-star safety rating.[52]

Automatic Emergency Braking Systems

In March 2016, NHTSA announced a commitment by twenty automakers to make AEB systems a standard feature on virtually all new cars by 2022.[53] According to NHTSA, this voluntary agreement will make AEB systems a standard feature in new cars three years faster

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44 Id.
45 Id.
46 Id.
47 See https://one.nhtsa.gov/nhtsa/av/av-policy.html
48 Id.
49 See https://one.nhtsa.gov/cars/problems/studies/1999-01-0064/1999-01-0064.html
50 See https://www.federalregister.gov/documents/2015/12/16/2015-31323/new-car-assessment-program
51 See https://www.gpo.gov/fdsys/pkg/FR-2015-12-16/pdf/2015-31323.pdf
52 Id.
53 See https://www.nhtsa.gov/press-releases/us-dot-and-iihs-announce-historic-commitment-20-automakers-make-automatic-emergency

than they would have become a standard feature had NHTSA pursued this effort through a formal regulatory process.[54] It is estimated that during these three years, this commitment among automakers will prevent 28,000 crashes and 12,000 traffic-related injuries.[55]

IV. ISSUES

The following issues will be examined at the hearing:

- Safety implications of advanced driver assistance systems and crash avoidance technologies.
- How advanced driver assistance systems inform the development of self-driving cars.
- SAE levels of driving automation.
- Consumer education, awareness, and training of advanced driver assistance systems and crash avoidance technologies.
- Privacy and security considerations in the development and deployment of advanced driver assistance systems and crash avoidance technologies.

V. STAFF CONTACTS

If you have any questions regarding this hearing, please contact Paul Nagle or Olivia Trusty of the Committee Staff at (202) 225-2927.

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[54] Id.
[55] Id.