August 28, 2019

Heidi King
Deputy Administrator
National Highway Traffic Safety Administration
1200 New Jersey Avenue, SE
Washington, DC 20590

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Docket No. NHTSA-2019-0036

Intel Corporation Response to Advanced Notice of Proposed Rulemaking (ANPRM): Removing Regulatory Barriers for Vehicles with Automated Driving Systems

Dear Deputy Administrator King:

Intel Corporation appreciates the opportunity to respond to the U.S. Department of Transportation's (USDOT) National Highway Traffic Safety Administration (NHTSA) Advanced Notice of Proposed Rulemaking on *Removing Regulatory Barriers for Vehicles with Automated Driving Systems* (ADS).

We applaud USDOT and NHTSA's continued leadership in advancing the safe testing and deployment of automation technologies in motor vehicles and motor vehicle equipment. Intel has strongly supported the Department's efforts to advance automated vehicle technologies in order to enable increased safety, and ensure that the U.S. remains a technology leader in automated vehicle innovation and investment.

Like USDOT and NHTSA, we believe that automated vehicles have the potential to transform our world, most importantly saving lives. As NHTSA has estimated, traffic crashes in the U.S. claimed 36,750 lives in 2018,[1] and the U.S. social harm (economic and societal impact) of motor vehicle

[1] *Early Estimate of Motor Vehicle Traffic Fatalities in 2018*, Report No. DOT HS-812-749 (June 2019), https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812749.

crashes is over $800 billion each year.[2] With 94 percent of serious crashes caused by human error – and the potential for automated vehicles to remove human error from the driving equation – the positive societal impact of automated vehicles is tremendous.

USDOT-NHTSA's Automation Principles and Goals

First, Intel concurs with the Department's "Automation Principles," including prioritizing safety first; technology neutrality among automation stakeholders; modernizing regulations to support performance-based technical standards; and a consistent regulatory and operational environment to enable automated vehicles to operate seamlessly across the nation. We also agree with NHTSA that "for ADS technologies to develop fully, technological and regulatory barriers must be overcome."[3] Automated vehicles may include unconventional designs that are incompatible with some existing Federal Motor Vehicle Safety Standards (FMVSS). Therefore, some FMVSS may need to be modernized to comprehend advances in ADS technology.

We also share NHTSA's goal to ensure that the testing methods specified for use in testing automated vehicles without traditional manual controls are practicable, objective and meet the requirements of the NHTSA's statutory authority, the Vehicle Safety Act.[4] Towards this end, Intel believes that it is important for the broader automated vehicle industry to collaboratively establish a transparent, technology-neutral, performance-based model for verifiable safety assurance for automated vehicle decision making, in partnership with global standards bodies (discussed in detail below). The U.S. is among the countries leading the way on the public policy front with *Preparing for the Future of Transportation: Automated Vehicles 3.0 (AV 3.0)*, making this the perfect time to engage in these collaborative next-step discussions on safety validation and verification at both the U.S. and international level.

Advance Safe and Targeted Automated Vehicle Testing for Crash Avoidance

Second, we concur with USDOT's statement in *AV 3.0* regarding ADS validation, verification and safety assurance: "On-road testing cannot be expected to address all aspects of safety assurance."[5] Indeed, in order to earn consumer trust, statistical data generated based exclusively on on-road testing like Vehicle Miles Traveled (VMT) and disengagements, are not a sufficient measure of safety. Thinking has evolved as we have learned more about automated

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[2] *Economic and Societal Impact of Motor Vehicle Crashes*, 2010 (revised), Report No. DOT HS-812-013. Washington, DC: NHTSA (May 2015), https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812013.

[3] *Removing Regulatory Barriers for Vehicles With Automated Driving Systems*, 84 Fed. Reg. 102, at 24433.

[4] *National Traffic and Motor Vehicle Safety Act of 1966*, as amended, 49 U.S.C. Chapter 301 (Vehicle Safety Act).

[5] *Preparing for the Future of Transportation: Automated Vehicles 3.0*, USDOT (Oct. 4, 2018), at 38.

vehicle systems and safety assurance, as all miles are not created equal and disengagements can be influenced by driving and engineering decisions, making these flawed metrics.[6]

Therefore, we support a more comprehensive yet focused test and analysis of the safety of vehicle's sensor and decision making systems, in both controlled test track and deliberative miles of on-road testing. This will ensure that the automated vehicle performs with an appropriate balance of safety and usefulness (traffic flow agility) in the real world. Specifically, we believe that testing of automated vehicle safety should be performed along three different paths – (i) controlled test track miles and deliberative on-road miles; (ii) verification of the vehicle's decision making capabilities to an industry accepted, performance-based safety model; and (iii) laboratory-based data-driven testing of the vehicle's sensor system to measure the probability of sensor system mistakes.

To ensure a safe automated vehicle, it is important to utilize all of these aspects of testing and apply the appropriate strategy to each. This means utilizing each aspect for what it does best:

- Test tracks enable ADS developers the space to perform controlled experiments on chosen safety-critical scenarios that would be undesirable to recreate in on-road testing; for example, they present an optimal place to put vehicles into NHTSA's pre-crash scenarios and test their crash worthiness, both in mitigating crashes or preventing them altogether – without risking the safety of other vehicles or road users.

- Deliberative on-road testing exposes automated vehicle platforms to complex traffic negotiation and interaction with human drivers and vulnerable road users, and enables assessment of the appropriate balance of safety and usefulness. In other words, if the automated vehicle drives in such a way that traffic flow is severely impacted due to overly conservative or overly cautious driving behavior, then the automated vehicle is not safe or useful in the real world. For this reason, it is important to target a deliberative number of on-road miles for the purpose of enabling experience interacting with other real world agents that simulators may struggle to replicate.

- Verification of the vehicle's decision making capabilities to an industry accepted, performance-based safety model ensures a vehicle is safe-by-design in advance of on-road use as opposed to after the fact (*i.e.*, after a crash has occurred).

- Laboratory-based, data-driven testing of the vehicle's sensor system to verify the operation of the sensing system based on probability of mistakes measured from real world data.

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[6] *Self-Driving Car Industry Needs Better Metrics, DOT Official Says*, Bloomberg, (Oct. 23, 2018), https://www.bloomberg.com/news/articles/2018-10-23/self-driving-car-industry-needs-better-metrics-dot-s-kan-says.

Promote a Collaborative, Technology-Neutral Safety Assurance Framework

Third, we believe it is very important for industry to collaborate on a technology-neutral methodology and test procedure for safety assurance, in partnership with global standards bodies, which USDOT-NHTSA could then adopt into motor vehicle safety standards. Consistent with USDOT and NHTSA's perspective, we believe in "Safety First" and "Public Trust" focus:

Safety First. Consistent with USDOT's safety-first "Automation Principle," we support industry collaboratively defining a universally acceptable set of safety assurance principles (immediately below) for automated vehicle systems. This will enable a common definition of what it means for an automated vehicle to drive safely, as well as a common metric to measure and assess the safety of an automated vehicle. Intel suggests the following high-level principles are essential components of a technology-neutral and performance-based approach to safety:

- Future safety test procedures, performance criteria and/or guidelines should adhere to the Vehicle Safety Act principles for FMVSS that "[e]ach standard shall be practicable, meet the need for motor vehicle safety, and be stated in objective terms."[7]

- Manufacturer self-certification should remain the U.S. governing framework.

- Future safety test procedures, performance criteria and/or guidelines should include pre- and post-deployment observability of a repeatable and deterministic (vs. probabilistic) safety model for the automated vehicle, in order to demonstrate safety assurance.

- To ensure a competitive marketplace that promotes safety and innovation, all industry stakeholders testing and/or deploying ADS and automated vehicles should be subject to the same testing and deployment policies under a uniform federal framework. Similarly, any new USDOT or NHTSA ADS or automated vehicle Advisory Committee or Working Group should reflect the breadth of industry stakeholders, from technology companies and other new entrants, alongside traditional OEMs and suppliers.

Consistent with these principles, Intel's Mobileye business unit published a transparent, technology-neutral mathematical model for ADS safety decision making called Responsibility-Sensitive Safety or RSS.[8] RSS formalizes what it means to be a safe driver into technology-neutral and transparent mathematical equations. It provides a detailed, practicable, and efficient solution for validating an automated driving system that results in a verifiable safe-by-design automated vehicle. As a parameterized model, RSS also enables

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[7] *Motor Vehicle Safety*, Title 49, United States Code, Chapter 301.

[8] *Responsibility-Sensitive Safety (RSS): A mathematical model for autonomous vehicle safety,* https://www.mobileye.com/responsibility-sensitive-safety/.

flexibility in setting the balance between the safety and usefulness of automated vehicles operating in the real world.[9]

Of note, a 2018 RAND report highlighted RSS as a "leading" measure (reflecting performance, activity, prevention) of a safe-by-design automated vehicle.[10] We also note that RSS may be used as a "lagging" measure (observations of safety outcomes or harm) to collect statistical evidence of frequency of dangerous situations and crashes. Moreover, Intel recently joined ten other automated driving and mobility industry leaders[11] to publish the *Safety First for Automated Driving* framework,[12] a first-of-its-kind framework for safe automated passenger vehicles, which defines a safe-by-design approach to automated driving. RSS is featured in this framework as an element for a safe-by-design automated vehicle.[13]

Public Trust/Consumer Education. Through public-private collaborations regarding consumer education, as well as transparent technical collaborations like we envision with RSS, industry and government can drive widespread acceptance of automated vehicles, thereby improving road safety. Indeed, transparency of automated vehicles' safety and decision making capabilities, together with first-hand experience with these vehicles, will help clarify and define societal expectations for automated vehicle performance and enable consumer trust.

For this reason, Intel is working with stakeholders across the broad automated vehicle industry to help build public trust in this transformative lifesaving technology, starting with education and adoption of advanced driver-assistance system technologies as a path to full autonomy. For example, Intel is proud to be a founding member of the Partners for Automated Vehicle Education (PAVE), a coalition of industry, nonprofit and educational institutions founded to educate the public on the safety benefits of automated vehicles.

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[9] Driving safely is often cultural and RSS, as a parametrized model, enables customization to ensure automated vehicles are "driving safely" as defined by each country (*e.g.*, U.S.) or region (*e.g.*, EU) where vehicle is operating.

[10] *Measuring Automated Vehicle Safety, Forging a Framework,* RAND Corporation (2018), at 29-32, https://www.rand.org/content/dam/rand/pubs/research_reports/RR2600/RR2662/RAND_RR2662.pdf.

[11] Aptiv, Audi, Baidu, BMW, Continental, Daimler, FCA, HERE, Infineon, Intel, Volkswagen.

[12] *Intel and Auto Industry Leaders Publish New Automated Driving Safety Framework* (July 2, 2019), https://newsroom.intel.com/news/intel-auto-industry-leaders-publish-new-automated-driving-safety-framework/#gs.q95rv4.

[13] *Automotive and Mobility Industry Leaders Publish First-of-its-Kind Framework for Safe Automated Driving Systems: Safety First for Automated Driving* (July 2019), at 55-56.

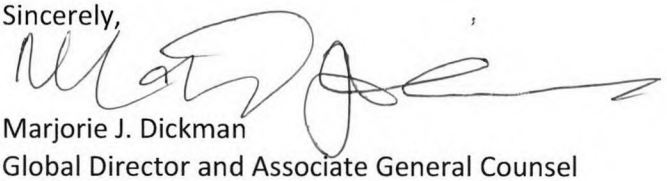
Conclusion

As USDOT iterated in *ADS 2.0* and *AV 3.0*, proving the safety of automated vehicles is essential to establish consumer trust, in order to realize the multifold benefits these vehicles will deliver. RSS is based on three fundamental pillars: 1) provable safety assurance; 2) practicable scalability; and 3) technology neutrality. We believe that a performance-based safety model aligned with these pillars, developed in partnership with leading automotive standards bodies, is essential to advance the safe future of automated vehicles in the U.S. and around the world.

Accordingly, as a nation and industry, we must invest in the collaborative discussion of such safety assurance models, common industry safety standards, and appropriate public policies. ANPRMs and public-private dialogues convened by USDOT-NHTSA, broad-based industry organizations aligning around common automated vehicle policy principles,[14] and global standards bodies like SAE, IEEE and ISO (as well as UNECE WP.29 at the international level) all play a key role in developing appropriate technical standards and public policies – and building the trust necessary to test and deploy automated vehicles at scale across the U.S. and globally.

Intel appreciates the opportunity to engage with USDOT and NHTSA through this comment process, as we work with partners across the automated vehicle sector to enable this life-saving technology. Thank you for your ongoing efforts to ensure American leadership in the safe testing and deployment of this transformative life-saving and mobility-enhancing technology.

Sincerely,



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[14] See, e.g., *U.S. Chamber – Technology Engagement Center (C_TEC) Automated Vehicle Policy Principles* (Aug. 2, 2019), https://www.uschamber.com/issue-brief/ctecs-automated-vehicle-policy-principles.