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RFI Title: ADS Safety Comments
Docket Number: NHTSA-2018-0092

November 26, 2018

United States Department of Transportation
1200 New Jersey Avenue, SE
Washington, DC 20590

NXP Semiconductors USA, Inc. submits this response to the Department of Transportation's request for comment on its Advance Notice of Proposed Rulemaking (ANPRM) on the near and long-term challenges of Automated Driving Systems (ADS) testing, development and eventual deployment. As the world's number one provider of automotive semiconductors spanning the entire range of applications from safety and critical systems to infotainment, NXP has assumed a leadership position in semiautonomous and autonomous vehicle technology. Our solutions help ensure that every journey will be safe, secure, and enjoyable and we are happy to provide comment to this ANPRM.

About NXP:
Built on a 50-year legacy with Motorola and Philips, NXP (www.nxp.com Nasdaq: NXP) has design, research and development, manufacturing and sales operations in the United States, where we employ approximately 6,000 people. NXP owns and operates three wafer fabrication facilities in the US, two of which are in Austin with a third facility in Chandler, Arizona. The representative products of these fabs include microcontrollers (MCUs) and microprocessors (MPUs), power management devices, RF transceivers and amplifiers, and sensors. NXP is a proud supporter and industry technology sponsor supporting the US Department of Transportation Smart City Challenge. We are currently furnishing the City of Columbus, Ohio with a comprehensive V2X solution.

Terms used in this response:
The following glossary will help in the understanding of various components of this response.

- **Automated Vehicles**
- **Connected Vehicles**
- **Dedicated Short-Range Communications** (DSRC) is a two-way short to medium-range wireless communications capability that permits very high data transmission critical in communications-based active safety applications. The Federal Communications Commission allocated 75 MHz of spectrum in the 5.9 GHz band for use by Intelligent Transportation Systems vehicle safety and mobility applications.
- **Onboard Units** (OBU)
- **Roadside Units** (RSU)
- **V2V**
- **V2X**

Question 1. What potential factors should be considered in designing the structure of a pilot program that would enable the Agency to facilitate, monitor and learn from on-road research through the safe testing and eventual deployment of vehicles with high and full driving automation and associated equipment?

A primary question is whether the surrounding infrastructure is capable of supporting V2V and V2X communications. The density of the deployment of CV/AV technology must be considered. Smart vehicles are capable of communicating with other smart vehicles, but legacy vehicles will obviously be dominant in any open/unrestricted pilot environment and must be accounted for. An ideal CV/AC deployment would occur in a completely connected environment, for example in an air or sea freight port setting where clear boundaries and perimeters and controlled access exist. As the level of automation increases, risks grow exponentially, such that a full Level 5 AV pilot would best be conducted in a closed environment. That said, generalized connected vehicle pilots built on a DSRC V2X platform could be integrated into nearly any city environment.

A further aspect of on-road research that must be considered are prospects for interactions in the real world between automated vehicles and legacy, non-automated vehicles.

Question 2. If NHTSA were to create a pilot program, how long would there be a need for such a program? What number of vehicles should be involved? Should NHTSA encourage the conducting of research projects in multiple locations with different weather conditions, topographical features, traffic densities, etc.?

A suitable testing period would be conducted in phases, with the phases correlated with the SAEW vehicle autonomy levels, with certifications or similar endorsements and authorizations issued at critical proof points. NHTSA should indeed support the multiple projects in multiple locations with different weather conditions, topographical features, traffic densities, etc. Moreover, should NHTSA wish to establish a pilot program combining autonomous vehicle technology with connected vehicle technology – which provides a maximum degree of safety, and as such should be an element of any such pilot – NHTSA should take into account that DSRC technology utilizing 802.11p communications protocols in the 5.9 GhZ spectrum and permitting vehicle-to-vehicle and vehicle-to-infrastructure technology is essentially a standardized, proven technology, whereas cellular-based vehicle communications technology has not yet been fully tested nor standardized.

Question 3. What specific difficulties should be addressed in designing a national vehicle pilot program for vehicles with high and full driving automation either through the exemption request process relevant for FMVSS or more broadly related to other areas of NHTSA and/or other authorities.

It would be important that the transportation infrastructure support vehicle-to-vehicle (V2V) communications which can be accomplished through data exchange which occurs via radio signals designated as DSRC, defined below, and occur nearly instantaneously between vehicles without the need for operator intervention. Vehicles exchange information on speed, trajectory, etc., signaling the driver via a human-machine interface (HMI) about road conditions, environmental hazards, traffic signal timing, and more.

It would be necessary to provide a network of smart intersections, outfitted with RSUs, to enable basic connected vehicle implementation. The installation of RSUs and integration with traffic management centers is not overly complex, but with DSRC communications between vehicles, throughput at intersections and flow control along heavily-utilized corridors could be managed for greatest efficiency. Vehicles would be able to communicate seamlessly to take advantage of available roadways, adjusting signal phase and timing, etc.

Question 4. How can existing statutory provisions and regulations be more effectively used in implementing such a pilot program?

The preservation of the 5.9 GhZ spectrum that the Federal Communications Commission has currently reserved for DSRC-based automotive safety applications should continue to be protected for the purpose of enabling lifesaving DSRC functionality. Additionally, the authorizing legislation, regulations, and policies enabling the National Science Foundation and Department of Transportation to issue smart mobility-related grants and promote pilot programs such as is contemplated in the present action should be supplemented to support the continued, accelerated development of lifesaving technologies that in parallel also promote efficiency and facilitate greatly reduced emissions.

Question 5. Are there any additional elements of regulatory relief (e.g., exceptions, exemptions, or other potential measures) that might be needed to facilitate the efforts to participate in the pilot program and conduct on-road research and testing involving these vehicles, especially those that lack controls for human drivers and thus may not comply with all existing FMVSS?

Question 6. What vehicle design elements might replace existing required safety equipment and/or otherwise enhance vehicle safety under reasonably anticipated operating conditions?

Advanced Driver Assistance Systems (ADAS) are the foundation of increasingly automated cars. NXP masters the full complexity of 'self-driving robot' technology, offering silicon-based solutions that span a range from SAE Levels 1-5 providing the ability to sense, think and act:

- Sensing: radar, secure V2X, and vision technologies act as a vehicle's state-of-the-art eyes and ears.
- Thinking: Holistic intelligence collected and analyzed across all architecture domains enables reliable decision-making. Sensor fusion at high performance and low power is at its core.
- Acting: Smart actuators—including motor control, power/battery management, intelligent amplifiers, and LED drivers.

Question 7. What types of performance measures should be considered to ensure safety while allowing for innovation of emerging technology in vehicles with high and full driving automation participating in a pilot program?

Anonymized data related to individual vehicle safety and efficiency increases (as with, for example, existing city vehicles equipped with aftermarket ADAS technology) would prove invaluable for purposes of refining the technology.

Question 8. How should the Operational Design Domains of individual vehicle models be defined and reinforced and how should Federal, State and local authorities work together to ensure that they are observed?

Question 9. What type and amount of data should participants be expected to share with NHTSA and/or with the public for the safe testing of vehicles with high and full driving automation and how frequently should the sharing occur?

Question 10. In the design of a pilot program, how should NHTSA address the following issues—

a. confidential business information?

b. privacy?

c. data storage and transmission?

d. data retention and reporting?

e. other elements necessary for testing and deployment?

Question 11. In the design of a pilot program, what role should be played by

a. The 12 safety elements listed in “A Vision for Safety?”

b. The elements listed below,

i. Failure risk analysis and reduction during design process (functional safety)?

ii. Objective performance criteria, testable scenarios and test procedures for evaluating crash avoidance performance of vehicles with high and full driving automation?

iii. Third party evaluation?

A. Failure risk reduction?

B. Crash avoidance performance of vehicles with high and full driving automation?

iv. Occupant/non-occupant protection from injury in the event of a crash (crashworthiness)?

v. Assuring safety of software updates?

vi. Consumer education?

vii. Post deployment Agency monitoring?

viii. Post-deployment ADS updating, maintenance and recalibration?

c. Are there any other elements that should be considered?

Question 12. Are there any additional critical areas to consider in the design of a safe pilot program for the testing and deployment of vehicles with high and full driving automation?

Additional critical areas to consider in the design of a safe pilot program for the testing and deployment of vehicles with high and full driving automation include locating or establishing test bed areas with sufficient and uniform traffic controls and lane markings. Additionally, the inclusion of smart roadside infrastructure and signage can help to close any possible safety gaps to achieve near 100% redundancy. For example, while optical systems and machine learning/artificial intelligence can identify a stop sign with an extremely high degree of certainty, a smart stop sign capable of emitting a radio signal identifiable by a connected or automated vehicle can provide 100% certainty that the approaching vehicle with detect the sign's presence and react accordingly.

Question 13. Which of the following matters should NHTSA consider requiring parties that wish to participate in the pilot program to address in their applications?

a. "Safety case" for vehicles to be used in the pilot program (e.g., system safety analysis (including functional safety analysis), demonstration of safety capability based on objective performance criteria, testable scenarios and test procedures, adherence to NHTSA's existing voluntary guidance, including the submission of a voluntary safety self-assessment, and third-party review of those materials).

i. What methodology should the Agency use in assessing whether an exempted ADS vehicle would offer a level of safety equivalent to that of a nonexempted vehicle? For example, what methodology should the Agency use in assessing whether an ADS vehicle steers and brakes at least as effectively, appropriately and timely as an average human driver?

b. Description of research goals, methods, objectives, and expected results.

c. Test design (e.g., route complexity, weather and related road surface conditions, illumination and institutional review board assessment).

d. Considerations for other road users (e.g., impacts on vulnerable road users and proximity of such persons to the vehicle).

This is a critical aspect and should be a part of any such pilot program. Vulnerable road users (VRUs) will in the near term have the option of utilizing several active and passive means to protect themselves from vehicular impacts. Some of this technology already exists, such as simple, low-cost, and highly effective passive RFID tags which can be carried on one's person or affixed to a bicycle, motorcycle, item of clothing, or backpack. VRUs will also ultimately have the ability to selectively receive alerts from vehicles, as well as traffic management systems, regarding potential danger.

e. Reporting of data, e.g., reporting of crashes/incidents to NHTSA within 24 hours of their occurrence.

f. Recognition that participation does not negate the Agency's investigative or enforcement authority, e.g., independent of any exemptions that the Agency might issue to program participants and independent of any terms that the Agency might establish on those exemptions, the Agency could conduct defect investigations and order recalls of any defective vehicles involved in the pilot program. Further, the Agency could investigate the causes of crashes of vehicles involved in the program.

g. Adherence to recognized practices for standardizing the gathering and reporting of certain types of data to make possible the combining of data from different sources and the making of statistically stronger findings.

h. For which types of data would standardization be necessary in order to make such findings and why?

Anonymization of data related to individual vehicle safety and efficiency increases (as with, for example, existing city vehicles equipped with aftermarket ADAS technology) would be critical.

i. To what extent would standardization be necessary for those types?

j. Occupant/non-occupant protection from injury in the event of a crash (crashworthiness).

k. Assuring safety of software updates. – Yes. NXP is strongly supportive of full-vehicles over-the-air updates as a baseline for data security and privacy. The mechanisms for enabling this are explained in the following link:

http://www.nxp.com/docs/en/white-paper/Making-Full-Vehicle-OTA-Updates-Reality-WP.pdf

l. Consumer education.

m. Post-deployment monitoring.

n. Post-deployment maintenance and calibration considerations.

Question 14. What types of terms and conditions should NHTSA consider attaching to exemptions to enhance public safety and facilitate the Agency's monitoring and learning from the testing and deployment, while preserving the freedom to innovate, including terms and conditions for each of the subjects listed in question 13? What other subjects should be considered, and why?

Question 15. What value would there be in NHTSA's obtaining one or more of the following potential categories of data from the participants in the pilot program? Are there other categories of data that should be considered? How should these categories of data be defined?

a. Statistics on use (e.g., for each functional class of roads, the number of miles, speed, hours of operation, climate/weather and related road surface conditions).

b. Statistics and other information on outcome (e.g., type, number and cause of crashes or near misses, injuries, fatalities, disengagements, and transitions to fallback mechanisms, if appropriate).

c. Vehicle/scene/injury/roadway/traffic data and description for each crash or near miss (e.g., system status, pre-crash information, injury outcomes).

d. Sensor data from each crash or near miss (e.g., raw sensor data, perception system output, and control action).

e. Mobility performance impacts of vehicles with high and full driving automation, including string stability of multiple consecutive ADS vehicles and the effects of ADS on vehicle spacing, which could ultimately impact flow safety, and public acceptance.

f. Difficult scenarios (e.g., scenarios in which the system gave control back to an operator or transitioned to its safe state by, for example, disabling itself to a slow speed or stopped position).

g. Software updates (e.g., reasons for updates, extent to which updates are made to each vehicle for which the updates are intended, effects of updates). This data would be useful to assist OEMS determine what is the best method to deploy updates (Over the air, bring vehicle in for maintenance, etc.)

h. Metrics that the manufacturer is tracking to identify and respond to progress (e.g., miles without a crash and software updates that increase the operating domain).

i. Information related to community, driver and pedestrian awareness, behavior, concerns and acceptance related to vehicles with high and full driving automation operation. For example, if vehicles with high and full driving automation operated only in limited defined geographic areas, might that affect the routing choices of vehicles without high and full driving automation? For another example, if vehicles with high and full driving automation are programmed to cede right of way to avoid collision with other vehicles and with pedestrians and cyclists, might some drivers of vehicles without such automation, pedestrians and cyclists take advantage of this fact and force vehicles with high and full driving automation to yield to them?

j. Metrics or information concerning the durability of the ADS equipment and calibration, and need for maintenance of the ADS.

k. Data from “control groups” that could serve as a useful baseline against which to compare the outcomes of the vehicle participating in the pilot program.

l. If there are other categories of data that should be considered, please identify them and the purposes for which they would be useful to the Agency in carrying out its responsibilities under the Act.

m. Given estimates that vehicles with high and full driving automation would generate terabytes of data per vehicle per day, how should the need for data be appropriately balanced with the burden on manufacturers of providing it and the ability of the Agency to absorb and use it effectively?

n. How would submission of a safety assurance letter help to promote public safety and build public confidence and acceptance?

o. For all of the above categories of information, how should the Agency handle any concerns about confidential business information and privacy?

Question 16. How should the Agency analyze safety in deciding whether to grant such exemptions under each of the separate bases for exemptions in section 30113? Can the exemption process be used to facilitate safe and effective ADS development in an appropriate manner?

Question 17. Could a single pilot program make use of multiple statutory sources of exemptions or would different pilot programs be needed, one program for each source of exemption?

Question 18. To what extent would NHTSA need to implement the program via new regulation or changes to existing regulation? Conversely, could NHTSA implement the program through a non-regulatory process? Would the answer to that question change based upon which statutory exemption provision the agency based the program on?

Question 19. How could the exemption process in section 30113 be used to facilitate a pilot program? For vehicles with high and full driving automation that lack means of manual control, how should NHTSA consider their participation, including their continued participation, in the pilot program in determining whether a vehicle would meet the statutory criteria for an exemption under section 30113? More specifically:

a. Would participation assist a manufacturer in showing that an exemption from a FMVSS would facilitate the development or field evaluation of a new motor vehicle safety feature providing a safety level at least equal to the safety level of the FMVSS, as required to obtain an exemption under section 30113(b)(ii)? If so, please explain how.

b. Would participation assist a manufacturer in showing that compliance with the FMVSS would prevent the manufacturer from selling a motor vehicle with an overall safety level at least equal to the overall safety level of nonexempt vehicles, as required to obtain an exemption under section 30113(b)(iv)? If so, please explain how.

c. The Agency requests comment on what role a pilot program could play in determining when to grant an exemption from the "make inoperative" prohibition under section 30122 for certain "dual mode" vehicles. Relatedly, what tools does NHTSA have to incentivize vehicles with high and full driving automation that have means of manual control and thus do not need an exemption to participate in the pilot program?

Question 20. What role could exemptions under section 30114 play in the pilot program? Could participation in the pilot program assist a manufacturer in qualifying for an exemption under section 30114? Could participation be considered part of the terms the Secretary determines are necessary to be granted an exemption under section 30114 for vehicles that are engaged in "research, investigations, demonstrations, training, competitive racing events, show, or display"?

Question 21. What role could a pilot program play in determining when to grant an exemption from the "make inoperative" prohibition under section 30122 for certain "dual mode" vehicles? Relatedly, what tools does NHTSA have to incentivize vehicles with high and full driving automation that have means of manual control and thus do not need an exemption to participate in the pilot program?