March 5, 2018

Brandy L Hendrickson  
Acting Administrator, Federal Highway Administration (FHWA)  
U.S. Department of Transportation (USDOT)  
1200 New Jersey Ave SE  
Washington, DC 20003

Reference: Docket No. FHWA-2017-0049

Dear Acting Administrator Hendrickson,

Thank you for the opportunity to provide comments to the January 18, 2018 Notice on Automated Driving Systems (ADS). The Intelligent Transportation Society of America (ITS America) believes that continued Federal Highway Administration (FHWA) support for research and guidance is important. The association commends FHWA for reaching out to industry to understand the infrastructure needs for automated vehicles.

ITS America is an association of public and private organizations that are focused on advanced vehicle technology, smart cities, and new models for mobility. Our members include automakers, telecomm, traditional IT and emerging tech, and consumer apps and industrial electronics. We also include public agencies and non-profits, such as road, transit and other transportation infrastructure operators and the research community focused on bringing new technology from the lab to our roads, cars, buses and trucks. Our objective is to grow our economy and improve our quality of life through innovative technologies that enhance the mobility, safety, security, privacy, sustainability and accessibility of our transportation system in the next decade.

ITS America’s key priorities for 2018 have been to establish the foundation for the deployment of automated and connected vehicles. Public confidence in the safety of the technology must be first achieved and then expanded in order for the technology to succeed commercially. We have been active in educating key stakeholders on issues in reference to the AV START Act (S 1885) and the SELF-DRIVE Act (HR 3388). As we stated before, ITS America believes there is a long-term role for states and localities to make road infrastructure and operations more accommodating and predictable for highly automated vehicles.

Most highly automated vehicle/ADS designs include models of traffic rules, three dimensional geospatial roadway geometry, traffic control devices (lane markings, speed limit signs, traffic signals etc.), as well as maps and landmarks that support tactical navigation (e.g. path planning and driving). The higher the level of automation, as defined by Society of Automotive Engineers (SAE) recommended practice J3016 (level 0 no automation to level 5, full automation), the more sophisticated these models and maps are. Also the wider the Operational Design Domain, the more sophisticated of ADS models and maps must be.

Unlike levels of automation, which industry has more clearly defined and reflected in SAE J3016, Operational Design Domains (ODD) are not as precisely classified. Road network configurations greatly determine model scenarios where multiple vehicles, or pedestrians and vehicles, come physically together in potentially conflicting time, intent and space. Traversing intersections, changing lanes, merging from off ramps, exiting to on-ramps, and entering and exiting parking, all depend on roadway configuration. Roadways are diverse, from freeway, arterial, collector/distributor, and local roads, intersections, traffic circles and ramps, each with different lane configurations and access rules, and traffic control device placement that support these configurations. These configurations also change temporarily with road construction within work zones, with some construction efforts leading to redesign of some roadways. Weather conditions are also a factor, especially where weather and
infrastructure configuration interact (e.g. where storms might destroy signage or degrade utility of traffic control devices etc.).

Generally, where ADS models/maps are well defined, there is a high confidence in the familiarly and low likelihood of change in the nature and condition of the infrastructure and this often determines the system’s ODD. Some technology companies and automakers may very narrowly define their ODD. Waymo, in its 2018 Safety Report, for example, stated that “An operational design domain can be very limited: for instance, a single fixed route on low-speed public streets or private grounds (such as business parks) in temperate weather conditions during daylight hours…” software will not create a route that travels outside of a “geo-fenced” area.1 General Motors 2018 Self-Driving Safety Report states that “…vehicles will remain within designated, premapped areas. The vehicle’s computers treat these mapped areas as a strict boundary, or geo-fence, for the vehicle.”2

While designs vary, most ADS models/maps are compared with real-time inputs from a combination of active sensors (e.g. radar, Lidar, infrared, piezoelectrical etc.), passive sensors (e.g. camera based detection) and even vehicle-infrastructure communications (traffic signals that may beacon signal phase status). An ADS system then processes those inputs, plots a path, and sends instructions to the vehicle’s powertrain and control systems to manage acceleration, braking, and steering. ADS models/maps of the roadway environment also throw potential obstacles into starker relief – an object that would not be expected to be seen present on a map (e.g. debris that has randomly fallen on the roadway) is detected and classified sooner and tracked as a potential danger.

There are a number of companies that either build ADS model/maps either for themselves or for others. Furthermore, companies or even infrastructure operators may license or make publicly available geospatial data that may include road edges, lane markings, stop bars, and traffic signals and other traffic control devices, etc. – map data that is relevant to ADS, but collected for other purposes, often as part of a comprehensive asset maintenance or road project design effort. The departments of transportation for Utah (UDOT) and California (CALTRANS), for example, are already collecting high-definition imagery and three-dimensional laser scans of their roads and roadway assets, storing these data in geographic information systems.

The example of Utah is notable. The Utah Department of Transportation (UDOT) Roadway Imaging and Inventory program called for the collection of 14,000 miles of geolocated road geometry, pavement distress, surfaces, imagery, lane-mile, bridge clearance and sign data and was expanded to require collection of nearly all right-of-way assets. Utah has also made inventory data available across all divisions within the department through its UPL AN website, which includes data describing the roadway asset purpose and function, as well as other metadata.

There is much experimentation and innovation in higher level ADS approaches by a number of companies, and there likely will be for some time. Sensor suites and imaging procedures, and therefore data collection and processing approaches, differs across industry. Understanding that there are over 4 million miles of road in the United States, collecting spatial data that will support the operation of automated vehicles on every road in the country is a task of immense scale.3 Reducing the cost and improving the scalability of production and maintenance of ADS models and maps are likely a critical success factor for highly automated vehicles that have the capability to operate in a variety of geographical areas across a number of operational design domains.

Data sharing will also likely be a challenge. The biggest problem with multiple, simultaneous data collection and mapping efforts from different organizations is “source domain complexity.” Specifically, “source domain” complexity means taking data out its source domain acquired by a specific method and/or for specified purpose, and applying it to a target domain, which often requires laborious and intricate transformations to achieve meaningful results. A few collaborative efforts have begun to look for “cross-domain” standardization that address functional safety data, such as the Open AutoDrive Forum, which is a consortium of groups that have developed standards for Advanced Driver Assistance Systems (ADAS), traveler information systems and navigation data.4 However, the use of infrastructure asset management systems are not yet fully envisioned. Utah DOTs UPLAN or University of Maryland Center for Advanced Transportation Technology (CATT) Lab RITIS system are potential

---

1 Waymo Safety Report https://waymo.com/safetyreport/
3 United States Department of Transportation Bureau of Transportation Statistics, Table I-4, Public Road and Street Mileage in the United States by Type of Surface, 2012.
4 Open AutoDrive Forum http://www.openautodrive.org/
data sharing models to consider. FHWA may want to explore whether infrastructure operator data could directly supplement or be leveraged to improve the integrity of road data integral to the operation of ADS.

There are new infrastructure technologies that may improve ADS performance. There is an effort to design new types of road markings, signs, and other kinds of connected infrastructure that would make driving in highly automated vehicles potentially safer. Existing traffic control devices, specifically signage, road markings and traffic signals were designed for human drivers and use shapes colors, graphs and texts to convey relevant information. Making these devices easier for machines to read, or to embed additional static data that would be relevant to automated driving system is a potential innovation. For example, 3M has experimented with embedding coded machine-readable GPS coordinates and other metadata into road signs to provide information to driverless cars. In its I-75 Modernization project, 3M will be providing Michigan Department of Transportation with advanced all-weather lane markings, retroreflective signs with smart sign technology and Dedicated Short Range Communications (DSRC) devices for vehicle-to-infrastructure communications.

As researchers from Stanford’s Artificial Intelligence Laboratory noted “the hardest perception and reasoning tasks still remain unsolved to date, as no autonomous vehicle has yet demonstrated an ability to understand and navigate construction zones, accident areas, and other unexpected scenarios at nearly the proficiency of a human driver.” Since current autonomous vehicle prototypes, such as those being tested by a number of companies rely on a priori maps of the roadway for perception and path planning, temporary changes to the roadway may need to be disseminated on short notice. This may require a means for local traffic management centers to directly message driverless vehicles. It may also require other vehicles or personnel at the scene of a work zone or a crash to send secure ad-hoc safety or traveler information messages, using vehicle-to-vehicle, vehicle-to-infrastructure and vehicle-to-pedestrian (V2X) communications. Vehicle-to-X communications relies upon DSRC/Intelligent Transportation Services, as specified by the Federal Communications Commission (FCC). It should be noted, however, that FCC seeks to allow unlicensed services supporting wireless consumer internet access in its current proceeding on the 5.9GHz spectrum band, and final action in the proceeding may reconsider some types of DSRC/V2X services described above.

As ITS America wrote in its 2016 and 2017 comments to NHTSA on its Federal Automated Vehicle Policy proceedings, the association generally believes that for highly automated vehicles to navigate safely, roadways must be better maintained and modernized, traffic signals and ramp meters must be further standardized and connected, and road signage and lane markings may need to be upgraded. New driving conventions, such as how robotic vehicles might “wave through” pedestrians on crosswalks, or they how to identify and pull over for emergency vehicles, will be required for robotic vehicles to interact with other road users. Operations research must be conducted in order to ensure that the infrastructure operations and traffic codes can be adjusted where necessary to improve traffic safety while accommodating these new classes of advanced vehicles.

ITS America encourages FHWA to establish a dialogue with state and local transportation authorities, industry and the research community to address infrastructure safety. ITS America is encouraged by FHWA’s work, and commits to helping our members work with the agency and others to create foundation for the deployment of this new life-saving technology.

Sincerely,

/s/ Steven Bayless

Steven H. Bayless
Vice President, Public Policy and Regulatory Affairs
Intelligent Transportation Society of America

7 Special thanks to Anthony Shaw (Booz Allen) and Patrick Son (NOCOE) for their analysis and research while at ITS America