TOYOTA

Statement of

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****DRAFT****

Chairman Bucshon, Ranking Member Lipinski, and other Members of the Subcommittee, thank you for the opportunity to testify before you this morning. And thank you for holding this hearing on the future of surface transportation.

My name is Kristen Tabar. I am Vice President of the Technical Administration Planning Office at the Toyota Technical Center in Michigan. Prior to assuming this role several months ago, I was Vice President of Electronics at the Toyota Technical Center and oversaw Toyota's U.S.-based activities related to intelligent transportation technology, including vehicle-to-vehicle and vehicle-to-infrastructure communication. I started my career at Toyota in 1992 as an Associate Engineer responsible for vehicle application audio development.

Toyota has a long and proud history in the United States. Toyota produces over 1.2 million vehicles each year at our 10 U.S. manufacturing plants, including plants in Indiana, Texas, Mississippi, and Kentucky. We directly employ more than 32,000 people, and are responsible for the creation of 365,000 jobs, in the U.S. - including those that have been created by our 1,500 U.S. dealers and our network of U.S.-based suppliers. Over our more than 50 year history in the United States, we have directly invested more than $20 billion.

Toyota also has a long-standing and unwavering commitment to research and development. As the world's top-selling automaker, Toyota spends $1 million per hour globally on research and development activities that range from basic research to the development of new technologies and products. Toyota has consistently been ranked in the top 10 in terms of research and development spending by publicly traded companies, including being ranked #1 in spending in four of the last seven years.

Our commitment to research and development is evident in the United States, where we have formed and maintained world-class research and development facilities. The Toyota Technical Center is Toyota's leading technical center outside of Japan and has been the driving force behind our North American research and development activities for the past 25 years. Today, more than 1,100 engineers, scientists and technologists work at our Technical Center facilities in California and Michigan, and at our proving grounds in Arizona, to develop some of the smartest and most advanced cars and trucks on the road.

The Toyota Technical Center is also home to the Collaborative Safety Research Center (CSRC), which was launched in 2011 to serve as a catalyst for the advancement of auto safety in North America. CSRC works with leading North American universities, hospitals, research institutions and federal agencies on research projects aimed at developing and bringing to market new safety technologies to help reduce the number of traffic fatalities and injuries. Toyota has committed approximately $50 million to fund the Center and its research, with the vast majority of funding going to our research partners. Toyota has also adopted a unique open approach to CSRC's activities, making the results of our collaborative research available to federal agencies, our competitors, and academia.

In addition, our design research facilities in Michigan and California are serving as laboratories for new design ideas, providing an open field for form, shape, and materials exploration, and leading the way on future design and production engineering. Our Toyota InfoTechnology Center in Silicon Valley is working at the forefront of the rapidly-changing information technology sector and conducting research that will lead to greater innovation in the automobile industry. Our InfoTechnology Center is Toyota's technical lead on spectrum and other wireless-related research, including research related to vehicle-to-vehicle and vehicle-to-infrastructure communication.

A Vision of the Future

The automobile is currently undergoing a technological transformation that is helping to reduce crashes, improve fuel efficiency, and bring greater convenience and improved quality of life to drivers and passengers. However, despite the remarkable technological advances we've seen over the last decade, the truth is that we are only in the very early stages of this transformation. The innovation we will see in the future will be staggering.

Much of the transformation that is to come will be made possible by an increasing level of connectivity in vehicles. Cars will be connected to each other and to the world around them. They will be outfitted with next-generation telematics systems that will offer sophisticated information services, including real-time accurate traffic information and route optimization assistance to help people get to their destinations more efficiently. This type of information will certainly offer day-to-day convenience to drivers and passengers, but can also play a critical role in post-disaster situations when information on safe evacuation routes may be necessary.

In the future, there will be even more integration of vehicles and other mobile devices, offering seamless connectivity and unleashing new and innovative services, such as those that help people link diverse forms of mobility and public transportation to reach their destinations in the smartest way possible. Cars will also be communicating with homes and businesses as part of a smart energy management system and will have the ability to power your home with stored energy when electricity prices are high or during a power outage.

Most importantly, cars will be able to communicate with each other and with roadside infrastructure about potential hazards, slow or stopped vehicles ahead, or signals, signs, and road conditions that may be difficult to see. This communication capability can be coupled with advanced active safety technologies - including increasing levels of automation - that are capable of responding to the information and safely taking action to avoid the hazard altogether, potentially saving tens of thousands of lives in the United States each year.

An Introduction to Vehicle-to-Vehicle and Vehicle-to-Infrastructure Communication

There have been remarkable advances in the crashworthiness of vehicles in recent years, resulting in an impressive reduction in traffic casualties and fatalities. Despite this, however, more than 30,000 people are still dying in traffic accidents each year in the United States. Toyota and the automobile industry firmly believe that the next great opportunity to reduce injuries and fatalities from traffic accidents rests with the deployment of innovative new technologies that will prevent crashes in the first place.

Companies like Toyota are leading the way by outfitting vehicles with top-of-the-line sensors, like radars and cameras, that can identify and notify drivers of potential hazards. The revolutionary advances that sensor-based safety technologies are bringing to auto safety can be enhanced even further with vehicle-to-vehicle and vehicle-to-infrastructure communication. Communication-based technologies have greater range, field-of-view, and line-of-sight than sensor-based technologies, and can therefore identify collision threats at a greater distance or with a vehicle that is around a corner or behind a truck. It is the complementary combination and redundancy of communication capability and on-board sensor technology that will allow Toyota to make additional progress towards our ultimate goal of zero casualties from vehicle crashes. It is also the combination of these technologies that will open the door to automated vehicle systems in the future that are safe and reliable.

Vehicle-to-vehicle safety communication is enabled by two-way, short-to-medium range wireless communication capability. Vehicles broadcast precise information – such as their location, speed, and acceleration – several times per second over a range of a few hundred meters. Other vehicles outfitted with the technology receive these "messages" and use them to compute the trajectory of each neighboring vehicle, compare these with their own predicted path, and determine if any of the neighboring vehicles pose a collision threat.

Vehicles can also communicate with equipped roadside infrastructure, enabling additional information to be provided to drivers. This includes information about the potentially unique layout of an approaching intersection or road, the current and future state of upcoming traffic signals, and the existence of a potential hazard such as ice, fog, a disabled vehicle, a bicyclist, or a pedestrian.

If a vehicle determines that a potential collision or other hazard exists, the on-board system can warn the driver or, in the future, take action to avoid a collision. Feedback to the driver can be conveyed audibly, visually through a heads up display, dashboard screen, or other signal, or through a haptic mechanism (such as a shaking steering wheel or vibrating seat) and can be formulated to range in intensity based on the risk.

The potential of this technology to save lives is tremendous. In a 2010 report entitled *Frequency of Target Crashes for IntelliDrive Safety Systems*, the National Highway Traffic Safety Administration (NHTSA) concluded that connected vehicle technology – including both vehicle-to-vehicle and vehicle-to-infrastructure communication – has the potential to prevent a majority of the types of crashes that typically occur in the real world, such as crashes at intersections or while changing lanes. The longer-range capability that this technology offers over traditional sensors also allows these dangerous situations to be predicted long before they are imminent, providing for more time to avoid them safely.

It is important to note that, although our initial focus is on safety applications, this technology can - and almost certainly will – be used for many other applications beyond collision avoidance and related safety purposes. For example, it can be used to assist with navigation, to make electronic payments (tolls, parking, fuels, etc.), to improve fuel efficiency through speed pacing at traffic lights, or to gather and disseminate real-time traffic information. In addition, just as the Internet has moved far beyond its original limited email and file transfer applications, the technology is also likely to unleash creative and innovative connected car applications that are only just now starting to be imagined and envisioned. We have no doubt that the technology will save lives, improve the environment, create jobs, and help the United States to maintain technical leadership in a field that will be an important contributor to economic growth in the future

A Commitment to Vehicle-to-Vehicle and Vehicle-to-Infrastructure Communication

Toyota is committed to this critical safety technology. In Japan, we have already commercialized first-generation vehicle-to-infrastructure communication technology that provides specific and detailed information on stopped or slowed traffic, lane merges, and other road conditions. In addition, several months ago, we announced commercialization in Japan of an automated highway driving system. This revolutionary advanced driving support technology combines next-generation Lane Trace Control with cutting-edge cooperative-adaptive cruise control that uses vehicle-to-vehicle communication technology to help maintain a safe distance from the vehicle ahead. This is an important milestone in our journey to automated vehicles and one that would not be possible without the use of vehicle-to-vehicle communication technology.

We intend to bring these technologies to the United States in the near future. That is why we've been working closely with other automakers and the U.S. Department of Transportation (U.S. DOT) over the last decade on the development of this communication technology, and why we are pleased to be here with you today discussing the technology, its potential, and some of the challenges that exist.

Collaboration with the U.S. Department of Transportation

The research and development of vehicle-to-vehicle and vehicle-to-infrastructure communication technology in the United States is an example of a successful collaboration between industry, academia, and the Federal government. The truth is that we would not be as far along today if it hadn't been for the collaborative research that has taken place to date jointly by Toyota and other automakers in the U.S. and U.S. DOT.

For more than 10 years, U.S. DOT has been working closely with automakers in the United States through the Crash Avoidance Metrics Partnership (CAMP) on a range of research activities relating to vehicle-to-vehicle and vehicle-to-infrastructure communication - including proof of concept, feasibility demonstrations, and field testing - to prepare for widespread deployment of crash avoidance systems that use vehicle-to-vehicle and vehicle-to-infrastructure communication. At this point, pre-production prototypes have been developed by a number of automobile companies, including Toyota, and are currently supporting demonstrations and large-scale evaluations of the applications that address the most critical crash scenarios.

Toyota and seven other automakers supported a year-long connected vehicle pilot program with U.S. DOT in Ann Arbor, Michigan that was completed in August of last year. The Model Deployment, which included nearly 3,000 vehicles outfitted with the communication technology from different manufacturers, demonstrated vehicle-to-vehicle applications in real-world driving scenarios and verified the maturity and stability of the technology.

Efforts are currently underway to expand the Ann Arbor pilot program from 3,000 vehicles to 9,000 vehicles and then eventually to 20,000 vehicles. There are also corresponding efforts to expand equipped roadside infrastructure over large areas of the Ann Arbor area to further test and validate vehicle-to-infrastructure communication technology. In addition to the Michigan-based programs, pilot programs are popping up around the country to further demonstrate and evaluate the efficacy of the technology. These pilot programs are important next steps in the technology's maturation and essential components of ongoing efforts to garner public understanding and acceptance of these transformational technologies.

Technical and Policy Challenges

Certainly, we should celebrate that great strides have been made in the area of vehicle-to-vehicle and vehicle-to-infrastructure communication and that we are on the cusp of realizing the potential of this technology here in the United States. However, we should also acknowledge that a few key challenges remain. We believe that there are a number of steps that Congress and the Federal government could take to help overcome these challenges and spur the deployment of the technology.

1. **Wireless Spectrum**. The Federal government should preserve and protect the short- to medium-range wireless spectrum that is necessary to support vehicle-to-vehicle and vehicle-to-infrastructure communication in the U.S. This communication capability, which is known as dedicated short-range communication (DSRC), is based on the IEEE 802.11 wireless protocol, but has been adapted for this specific vehicle-to-vehicle and vehicle-to-infrastructure communication use.

   In 1999, the Federal Communications Commission (FCC) allocated 75 MHz of spectrum in the 5.9 GHz band to be used for DSRC and, in 2003, the Commission adopted the licensing and service rules for DSRC systems operating in the band. Unfortunately, as part of a legitimate desire to find additional spectrum that can be opened up to unlicensed use in order to support the proliferation of wireless devices, the FCC issued a Notice of

Proposed Rulemaking last year soliciting comments on the possibility of opening the 5.9 GHz band up to use by unlicensed devices.

For the auto industry and those who have been involved in the development of this technology, the use of the spectrum allocated for vehicle-to-vehicle and vehicle-to-infrastructure communication by unlicensed devices raises significant, and possibly insurmountable, concerns about the potential for harmful interference. Interference that results in delayed or missed driver warnings will undermine the connected vehicle system's entire foundation, rendering it essentially useless and putting the entire future of vehicle-to-vehicle and vehicle-to-infrastructure technology in the United States at risk. Although Toyota is strongly committed to it and its potential, we cannot responsibly deploy this "safety-of-life" technology unless the possibility of harmful interference from unlicensed devices is ruled out.

We are working closely with our colleagues in both the wireless and automobile industry on the possibility of sharing the spectrum with unlicensed users in a way that will eliminate the potential for harmful interference. This is a very difficult technical challenge, and will require a significant amount of time and effort. We strongly discourage the FCC or Congress from taking any further action to force spectrum sharing until this work is completed, a viable spectrum sharing solution is identified, and testing verifies that there is no harmful interference from unlicensed devices.

2. **Infrastructure Investment**. Vehicle-to-infrastructure communication offers important supplemental benefits to vehicle-to-vehicle communication that should not be ignored. This includes information about stopped vehicles ahead, complicated or sudden lane merges, and upcoming roadway construction, as well as the ability to detect pedestrians or bicyclists. Vehicle-to-infrastructure communication also enables communication from the vehicle to the infrastructure, providing a means through which transportation planners and policymakers can gain important information about when and how roads are being used.

   Intelligent transportation infrastructure also helps ensure greater value to drivers during the earliest stages of deployment. With intelligent transportation infrastructure in place, even the earliest adopters of the technology receive an immediate benefit the moment they drive a vehicle outfitted with the technology off the lot in the form of infrastructure-enabled warnings and information.

   The immediate benefit to drivers is in part why Toyota started with the commercialization of vehicle-to-infrastructure communication technology in Japan, where there is - and has been over time - a strong commitment by the government to intelligent transportation infrastructure investment. Unfortunately, since a similar commitment to intelligent transportation infrastructure does not exist in the U.S., Toyota and other automakers have been forced to flip that commercialization model on its head and start with the commercialization of vehicle-to-vehicle communication technology.

It would be unfortunate to shut the door on vehicle-to-infrastructure communication technology in the United States. For that reason, Congress and U.S. DOT should be looking at ways to incentivize or facilitate the build out of intelligent transportation infrastructure to support vehicle-to-infrastructure communication in the United States.

3. **NHTSA Rulemaking**

The results from the year-long connected vehicle pilot program in Ann Arbor served as the basis of a decision by NHTSA in February of this year to proceed with rulemaking to require vehicle-to-vehicle communication capability in future vehicles. We encourage NHTSA to proceed expeditiously with the formulation of these rules and to move towards finalization of those rules as quickly as possible. The sooner we have a full understanding of and clarity around the rules of the road under which we will be required to operate and what minimum functionalities, if any, will be required of us, the sooner we can incorporate those requirements and functionalities into our commercial deployment plans in the United States.

We believe that, if done correctly, the rulemaking has the potential to accomplish two important goals: (1) accelerating the penetration of the technology in vehicles from multiple manufacturers; and (2) setting a common communication protocol so that we can be assured not only that Toyota vehicles will be able to communicate effectively with vehicles from other manufacturers, but also that Toyota vehicles today will be able to communicate with Toyota vehicles tomorrow. These are important, and helpful, goals and we look forward to working with Congress and NHTSA to achieve them.

4. **Research and Development at the U.S. Department of Transportation**

There is more research that can, and should, be conducted by U.S. DOT and the automakers related to vehicle-to-vehicle and vehicle-to-infrastructure communication. For example, we believe that U.S. DOT can play an important role in supporting ongoing and expanded pilot programs to further demonstrate vehicle-to-vehicle communication technology and can help develop roadside infrastructure testbeds that will support further testing and evaluation of vehicle-to-infrastructure communication technology. We also believe that U.S. DOT should consider additional research with respect to autonomous driving technologies, including how vehicle-to-vehicle and vehicle-to-infrastructure communication technology can be leveraged effectively to support automated driving.

At the same time, we are excited and eager to move to the commercial deployment phase of the technology. To that end, we encourage U.S. DOT to focus additional resources on helping to ensure a smooth and rapid deployment of the technology. These activities could include education and outreach activities, including activities around privacy and security, to introduce state and local transportation agencies and the public to the technology. These activities could also include programs to facilitate access to and availability of after-market devices for vehicles already on the road that are not outfitted with the communication capability.

Privacy and Security

As with any new connected technology, there are legitimate concerns about security and privacy. The truth is that the success of the technology is in large part dependent on public acceptance, and public acceptance requires that the network be adequately secure and that the privacy of drivers and passengers be preserved. These issues are of the utmost importance to Toyota and the other automakers who have been involved in the development of the technology in the United States, and have both been top priorities from the outset.

In the very early stages of commercial deployment, Toyota envisions that our vehicles will use the vehicle-to-vehicle communication system to offer our drivers information or warnings about potential hazards. Only when we are sufficiently confident in the technology's ability to perform even in the most challenging situations, and only when our consumers have a full understanding and appreciation of the value of the technology, will we enable our vehicles to take action (braking, veering out of the way, etc.) in response to the hazard warnings that they receive. In other words, in the early days, we do not anticipate a full integration of the vehicle-to-vehicle communication system and the electronic control elements of a vehicle. To a significant extent, this will limit the ramifications of a potential cyber incident.

Over time, as the systems become more integrated, security will become an undeniably critical element. The good news is that the connected vehicle system is being developed to support the security that is required and to minimize the potential for hacking. The system has been designed so that a vehicle will only accept messages from another vehicle with a secure digital signature. Digital signatures are only provided to those devices that have been authorized, or credentialed, to be on the system.

This security system will require infrastructure, or a security backend, to issue certificates and perhaps even revoke certificates in the unusual case that someone is using legitimate credentials to send false or misleading messages. Discussions are currently underway between the various automakers and U.S. DOT on the best way to structure and fund this security infrastructure, including whether it should be a public-private partnership or whether it should be run exclusively by the private sector. We are confident that these issues will be worked out, and the infrastructure in place, to support the system by the time it is needed.

Similar steps have been taken to ensure the privacy of drivers and passengers. The system has been developed through privacy-by-design so that no personally identifiable information is transmitted with the messages. However, the industry has also gone a step further to ensure that even information that has the potential to serve as an identifier of the vehicle is not transmitted. For example, we realized that if the same security certificate remained with a vehicle over time, it could enable someone to potentially track a specific vehicle. As a result, we've designed the system so that multiple security certificates would be used by a single vehicle over the course of single trip. We've also made a conscious decision to break the envisioned certificate issuing organization into several components (one that validates certificate requests, one that generates new certificates, etc.) to help ensure that even an internal bad actor is unable to track a specific vehicle over time.

In addition, we are concerned that a vehicle's exact length and width information – which must be transmitted with the message so that neighboring vehicles can determine if the vehicle poses a collision threat – could potentially be used to identify a specific vehicle. As a result, we are working to randomize the length and width of vehicles within certain parameters so that the length and width transmitted at Point A will differ slightly from the length and width transmitted down the road at Point B. The result of this structured randomization is that the integrity and effectiveness of the messages are not compromised, but the ability to track a vehicle is also minimized.

We welcome discussions about security and privacy, and appreciate the opportunity to share the steps that we've tried to take as an industry to address these potential issues. At the same time, it would be tragic if uninformed or exaggerated concerns about security and privacy ended up chilling the further development of this transformational technology that will save lives. We need to fully understand the risks, communicate those risks clearly, and manage those risks by taking the steps necessary to make the system as secure as it can be while also protecting consumer privacy. We also need to be cautious about taking actions, including opening up the spectrum allocated to vehicle-to-vehicle and vehicle-to-infrastructure communication to other unrelated uses, that may introduce new security and privacy challenges.

Conclusion

Thank you, again, for the opportunity to testify before you today. This is truly an exciting time in the automobile industry, and we look forward to working with the Committee to realize the benefits of vehicle-to-vehicle and vehicle-to-infrastructure technology in the United States. I look forward to your questions.